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GEORGE G. MALLINSON
Editor
Western Michigan University
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JACQUELINE MALLINSON
Assistant Editor
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LUTHER SHETLER
Business Manager
P.O. Box 108, Bluffton, Ohio

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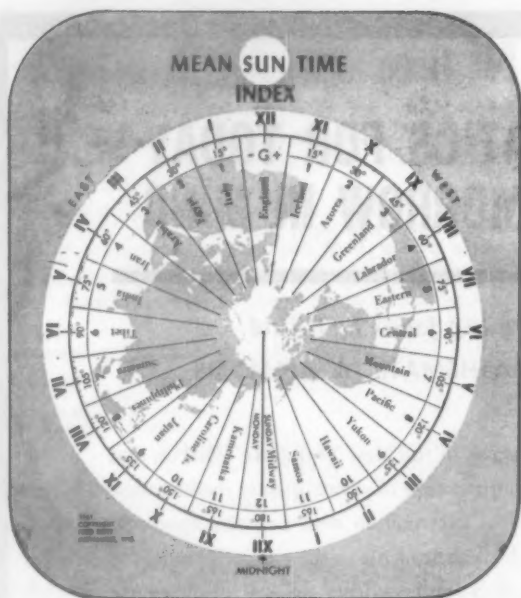
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School Science and Mathematics

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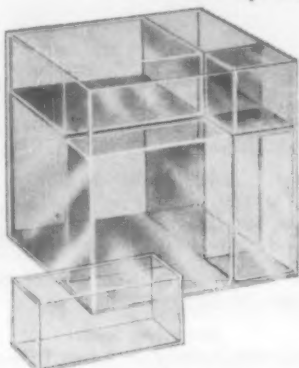
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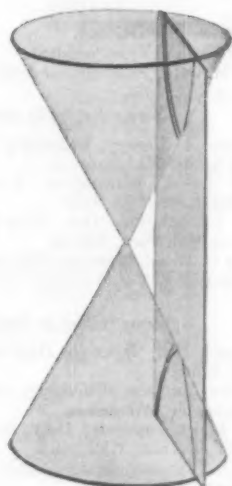
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How to Improve Science Teaching through Mathematics

Mrs. Lois M. Laper

Webb High School, Reedsburg, Wisconsin

Just how important is mathematics in high school science teaching? In general science about ten per cent of the exercises use mathematics. Most of this is arithmetic, which includes percentage, ratio, proportion, and measurement. In chemistry a little more than ten per cent of the exercises use mathematics. Proportions, percentage and simple equations are necessary to work the exercises. All this subject matter is found in a good course in general mathematics. In physics from fifty to seventy-five per cent of the problems use mathematics. For these problems it is necessary to solve many kinds of equations, extract square root, and substitute in formulas. This subject matter is found in most first year algebra courses. Physics also uses some geometry, such as similar triangles, finding the diagonal of a square and the side opposite the 30° angle is a 30° - 60° right triangle.

Since 1900 research people have urged the integration of science and mathematics. They have gone so far as to teach physics and mathematics together. This was not satisfactory because both courses need much developmental work and there was not time for both. The best way is to use science problems as exercises in mathematics and to use mathematics in the development and the study of physical laws. The latter involves relations between sets of numbers which the mathematician calls "function," and brings up the following vocabulary: variable, constant, dependence, equality, inequality, continuity. So it would seem that mathematics teachers need a science background and that science teachers need a mathematical background.

Mathematics textbooks do a pretty good job of using science problems in developing mathematical ability. For example, the algebra textbook I am using has lever problems as practice in solving equations with parentheses.

More should be done however. Formulas taken directly from the science textbooks used in the school where you are teaching can be used to practice substituting in formulas, both in general mathematics and in algebra. Work with ratios and proportions is scanty in most textbooks. Proportions are a powerful tool in working many science problems. The mathematics teacher should supply supplementary material by dittoed sheets.

The time element is very important in trying to improve science teaching through mathematics. If students study algebra as freshmen and physics as seniors, there will be little carry-over if there is no mathematics taken between. If the students take mathematics each year along with their science courses the carry-over is good. In order to help with problems that are encountered in the science courses I teach the algebra and proportions part of general mathematics early in the school year.

Let me quote from the *Teachers Letter*: "Teaching is a series of nudges—and learning is never one long jump." So if the mathematics teacher gives the students a nudge in the direction of the science problems, and the science teacher pushes toward mathematics, the students should make progress.

"FEEDBACK" ACCOUNTS FOR HEAVY SNOWS IN EAST

The word "feedback," once used mostly by engineers and computer specialists, is now being adopted by weathermen because it helps to explain the heavy snows that belted the eastern part of the nation with regularity last winter.

The feedback partially explaining the disastrous snowstorms is between the earth's surface and the atmosphere. It is a slow-moving feedback, taking four to seven days to operate, not quickly as does the thermostat regulating the furnace's output of heat in a house.

Part of the feedback mechanism bringing the snows, however, is due to the snow itself. Ground covered with snow reflects much more sunlight back into the atmosphere than does bare ground, thus preventing the surface from warming.

The cold earth surface helps to enhance the temperature contrast between the masses of warm moist air from ocean areas and cold polar air from Arctic regions. When two such differing air masses clash, severe storms are usually the result.

The larger the temperature difference between the cold and warm air masses, the more severe the storm tends to be, other factors being equal.

Another factor in the feedback pattern causing the recurring snowstorms is found in the world-circling river of air high in the atmosphere known as the "planetary wave." This very broad band of westward-moving air meanders in its globe-girdling path, and last winter had a pattern of four ridges and troughs.

One trough was high over most of the eastern half of the nation, allowing cold polar air to pour much deeper than usual into the country's midsection. While the trough held its average position, the pattern of heavy snowstorms continued.

Implications of Modern Teaching Trends in Junior High and High School Mathematics for the Teaching of Arithmetic in the Elementary Grades*

Bernard H. Gundlach

Associate Professor of Mathematics, Bowling Green State University, Ohio

I

In exploring the various reasons for the present concern with revision of the school mathematics curriculum, we find external and internal reasons. Prominent among the latter is the extraordinarily rapid development of our technological society during the past fifteen years. The irrestrainable advance of automation, still in its infancy, has already created demands for new tools and skills at almost the same rate at which it discards outmoded tools and skills. As mathematicians and as educators we face this question: do we provide our students with the new tools and skills without which there will be no adequate place for them in their society of tomorrow?

In the slower moving past we used to give our students *specific* tools and skills designed to handle *specific* jobs and problem situations. The real question we must face now is not whether these specific tools and skills will still be useful in the world of tomorrow, but rather whether the specific jobs and problem situations for which they were designed—adequately as it were—will still exist, say ten, fifteen years from now. All indications are that this will not be the case. Large areas of modern business and industry are already today dependent on such mathematical tools and skills as Linear Programming, Decision and Game Theories, and a rapidly growing variety of Statistics, to only mention a few. This trend is rapidly increasing. Are we giving our students of today the necessary tools and skills for tomorrow?

This seems to raise the question of whether we can predict just what the "new" tools and skills in the field of mathematics are going to be from the scanty information we glean from present developments. Looking over the developments of the past fifteen years, since the end of World War II and the advent of nuclear energy, and trying to project a corresponding and probably even more rapid development for the fifteen years that lie ahead, we can at best discern certain trends. Yet these trends are quite sufficient to re-orient our present teaching of mathematics. Rather than give our students—as we did in the past, and as to a large extent we are still doing today—specific tools for specific jobs, we must teach them now how to make their own

* A paper presented at the Annual Convention of the Central Association of Science and Mathematics Teachers, Detroit, Michigan, November 25, 1960.

tools (or mathematical models) for whatever jobs and problem situations they may have to face in the future.

Fortunately for our discipline, mathematics is structured in terms of certain fundamental *invariants* which neither change with historical development nor with transformations from one mathematical system to another. In simpler language, we can affirm that all of mathematics is fashioned from certain "raw materials"—Undefined Terms, Axioms, Definitions—by means of certain structural "composition rules"—Commutative, Associative, Distributive, Closure Properties, plus the Identity and Inverse Elements of Addition and Multiplication—, which are dynamically active in every bit of genuine mathematics—past, present, and future. Any revision trend which deserves serious consideration points in this direction. While our predominant teaching concern of the immediate past was with *How to Use Mathematics?*, our first concern for the immediate future must be with *How to Make Mathematics?*—how to make it and construct it from its few, fundamental, invariant ingredients.

II

Mathematics is being created in 3 fundamental steps:

- (1) A problem situation is experienced and analyzed until a *pattern* is discovered in it.
- (2) To make discourse concerning this pattern possible, a *symbolism* is invented to represent it.
- (3) This symbolism is elaborated and extended into an organized, systematic, and consistent *language*.

That language is a genuine piece of mathematics. Like any other language, it can now be learned by those who have the will and the patience to learn it.

Step 1 above, where new patterns are created, is generally the work of the rare, creative genius. Step 2, the invention of new symbolism, demands ingenuity rather than genius. Step 3, the fashioning of a consistent symbolic language and its extension to other problem areas requires logic, experience, and much hard work. The history of our discipline reveals that steps 1 and 2 are mostly performed by our young mathematical geniuses in the prime of their creative lives (20 to 30 years of age), while step 3 occupies the more experienced and mature minds.

When a newly created piece of mathematics finds its way by means of transactions and journals finally into our textbooks, it only reflects the highly polished and refined aspects of the 3rd step. The creative struggle of step 1, the thrilling experimentation of step 2 have become completely erased and eliminated from the polished final product

which is set before our students. It has become a chapter in a language, like in any other language, and it can now be learned by working one's way through "mountains" of rather unappealing "vocabulary," "grammar," and "syntax," before one can hope to tackle once more the enlightened and creative aspects of language—its "poetry," its "drama," its "literature."

In the traditional approach to the teaching of mathematics, most of us got bogged down in teaching "vocabulary" and "grammar," rarely even reached the refinements of "syntax," and found probably to our dismay, but certainly not to our surprise that all of this turned out to be pretty insipid "stuff" for the great majority of our students. Again and again there has arisen in all of us the insistent question: Does this have to be so?

III

For our new approach we postulate that it is *not* inevitable to forego the genial and ingenious aspects and attitudes of mathematics as they undoubtedly exist during steps 1 and 2. To properly self-motivate the learning of mathematics—rather than rely upon some foreign motivation from without—it is entirely sufficient to make our students feel AS IF they had created new patterns and invented new symbolism. Existing mathematical patterns can be *re-created*; existing symbolism can be *re-invented* and be *re-discovered* by our students, to give them the thrilling sensation of having been present at "mathematics in the making," and thus let them experience a bit of the thrill and of the intellectual adventure which abound everywhere in this, man's greatest intellectual creation.

This demands, of course, wise guidance by experienced and well-informed teachers. It requires also, that such an attitude toward mathematics be instilled in our youngsters from the very moment when they make first contact with our discipline.

This puts it squarely up to our *elementary* teachers to initiate and maintain the building of such an attitude of creative imagination and stimulating experimentation by surrounding their young students with an atmosphere of thrill and expectation, an atmosphere in which arithmetic is being *made* before it is learned.

We know that young children excel in activities in which things are being built or put together; all modern toys explore and exploit this trend. Our elementary teachers know this, and they also know how to create the necessary classroom atmosphere in which creation and discovery are most likely to take place. However, because of the "peculiarity" of their required college preparatory curriculum, in which mathematical subject matter preparation held and frequently still holds a place equivalent to from 2 to 4% of the total credits necessary

for teacher certification, they lack the indispensable mathematical background.

In-service training becomes, therefore, a necessity. While it must be stated in defense of our much accused elementary mathematics teachers that even the most traditional and conservative teaching of arithmetic was far better than the required 2 to 4% of subject matter preparation they have received, it must also be said that it is not sufficient to purchase a stack of some of the newly developed experimental materials (MSG, UICSA, UICSM, and others), press it in their hands by the end of the school year and tell them "This is what you are going to teach next fall." It is high time that school boards and school administrators on all levels recognize the imperative need for in-service training, and that they begin doing something constructive about it!

Any school district that really wishes to help its teachers and, through them, its students, can find means and ways to arrange for an adequate in-service program. Any such program is most efficient and easiest accepted when it is organized from *within* the school system, rather than being imposed by outside forces. There are many ways in which this can be done. Already there is a growing number of school systems that are experimenting with in-service training programs. Their experiences have been written up; their experimental materials are available, and there are dedicated people in the mathematics departments of nearby colleges and universities who stand ready to help. Our own mathematics program in the Greater Cleveland area is just one possible way of organizing a large-scale in-service program. There are many others, and one of them will very likely be suitable for your own use.

IV

It remains to consider what a skeleton outline for such in-service training for elementary teachers of mathematics should contain.

All elementary work originates from concrete situations. Sets or collections of concrete objects are "counted" by establishing one-to-one correspondences between sets of objects to be counted and sets of counters. Children experience this concretely in the form of one by one matching. Even beginning learners know how to count in some sort of mechanical fashion. To give meaning to the counting words and the corresponding numerals is the very first task of the elementary approach. This leads inevitably to the concept of "one." For an elementary approach, we may consider "one" and its visual symbol "1" as an undefined term, that is, we simply accept it "as given." Gradually the counters are replaced, in one to one correspondence, by 1's; to avoid confusion with the later concept of Place Value (where 11

would be interpreted as eleven), we define these sets of 1's as *addition* or *sum* sets. The Hindu-Arabic numerals, known by most children through previous rote-learning, are now presented with their true meaning: short names for additive collections of 1's.

$$1 \dots\dots\dots 1 = 1 \text{ or ONE}$$

$$1 \quad 1 \dots\dots\dots 1+1 = 2 \text{ or TWO}$$

$$1 \quad 1 \quad 1 \dots\dots\dots 1+1+1 = 3 \text{ or THREE}$$

etc.

etc. etc.

etc.

In this fashion we establish the natural (or counting) numbers—set N—once and for all on solid ground and with all due regard to concreteness. This will mean, of course, that any number which can be obtained by repeated addition of 1's is a natural number and the converse, that any natural number can be reduced to repeated addition of 1's. This is already the informal statement of the all-important *closure property* for addition of natural numbers. We mean by saying "set N is closed under addition" that the sum of *any* two natural numbers is again a natural number. This is not true for subtraction, as exhibition of cases like $3-3=\square$ and $3-4=\square$ show.

The same basic process is now extended to the addition of natural numbers in the sense that

$$2+3 \text{ will mean } (1+1)+(1+1+1) \text{ or } (1+1+1+1+1)$$

where the parentheses are introduced casually to indicate the 1's which were originally contained in one set. Though the above statement implies use of the associative property of addition, associativity is treated later; we simply accept here informally that a collection of 1's will have the same cardinal number regardless of the order in which the 1's were taken. Our next concern will then be with $3+2$.

$$3+2 \text{ will mean } (1+1+1)+(1+1) \text{ or } (1+1+1+1+1).$$

Since the short name for the set $(1+1+1+1+1)$ is 5, it is seen that both, $2+3$ and $3+2$ have the sum 5. This leads to writing $2+3=3+2$, and from there to the fundamental concept of *commutativity of addition*.

Arithmetical statements are made and arithmetical questions are asked in the form of equations and of placeholder equations respectively. Thus $2+3=\square$ asks for the value of the sum of 2 and 3. The

placeholder is to be replaced by the correct numeral 5. As soon as a so-called "basic fact" like $2+3=5$ is established, it is presented in 3 forms as placeholder equations: $2+3=\square$, $2+\square=5$, and $\square+3=5$. The 2nd of these equations will lead to subtraction as the *inverse* operation of addition. It is first shown quite informally that the replacement numeral for $2+\square=5$ and for $5-\square=2$ is the same. Later-on, this is formalized.

In the above presentation of the natural numbers as short names for additive collections of 1's we have omitted the *empty set*. As soon as subtraction has been informally introduced, zero is presented as the *cardinal number of the empty set*, a concept which will turn out to be fully adequate for Place Value as well.

When more than two numbers are to be added, the *associative property* is informally introduced. $(2+3)+4=2+(3+4)$ and many other similar examples are presented; in all of them the parenthesis is now to be interpreted as "perform the enclosed operation(s) first regardless of the written order of the sentence." The associative property, once introduced, is then being used continuously in all sorts of situations, but most particularly in connection with Place Value. Assuming that Place Value has been treated somehow, that is, that the children can transform the concept "ten 1's" into that of "1 ten," a situation involving the so-called "carrying" procedure will be solved by use of the associative property as follows:

$$7+5=\square$$

$$7+(3+2)=\square$$

$$(7+3)+2=\square$$

$$10+2=12$$

A transformation (change of form) like the foregoing is based, of course, upon the fundamental use of 10 (ten) as the base of our ordinary arithmetic.

The teaching of Place Value to the base 10 which occupies the major place in 1st grade arithmetic, makes use of manipulative devices that make the transition from "ten 1's" to "1 ten" plausible to even the slow learners. It would take another entire article to present this approach which has been found to be most successful in our Greater Cleveland Mathematics Program. Also, much use is made of commutativity and associativity of addition in our regularly scheduled *oral* arithmetic sessions (at least 10 minutes, 4 times a week, K through 8).

At least the idea of 0 as the *identity element of addition* is introduced by showing concretely (using sets) that all additions really start with

the empty set; in other words that $2+3=\square$ really means $0+2+3=\square$.

Additions of more than two addends include now repeated addition of the same number, as in $2+2+2+2=\square$. Multiplication is then introduced as "repeated addition," whereby $2+2+2+2=\square$ is abbreviated to $4\times 2=\square$. This "definition" of multiplication does not apply to the cases $1\times n=\square$ and $0\times n=\square$ (where n stands for any natural number). These two cases are treated only after the *distributive property* of multiplication over addition has been introduced. Actually, the distributive property is first informally presented through "story problems." "2 boys and 3 girls ride the bus and pay a dime each. How much did they pay altogether?" Granted that this is not a very exciting "story," it makes the point in question quite clear. Since all "story problems" are solved by translating the verbal form into arithmetical sentences and questions, this little problem becomes, when translated, $2\times 10+3\times 10=\square$. When the children then realize that (1) $20+30=50$ gives the correct solution and (2) that they might just as well have added the 2 and the 3 first and then multiplied that sum by 10, we have actually made the case that

$$2\times 10+3\times 10=(2+3)\times 10$$

which is in form a case of the distributive property.

The distributive property, once established informally, is now used continuously to extend the multiplication range of the beginning learner. Take the hypothetical case of a child who has learned all of the foregoing concepts and who is now engaged in learning the multiples of 2 and 3. Having mastered these two sets of multiples, he is presented with the problem $7\times 5=\square$. Since he has learned that multiplication can be interpreted as "repeated addition," he would be able to add seven 5's and thus obtain the value of the product as the sum 35. But having learned the distributive property informally, he can shorten this addition by writing

$$\begin{aligned} 7\times 5 &= 7\times (2+3) \\ &= 7\times 2+7\times 3 \\ &= 14+21 \quad (\text{already learned}) \\ &= 35 \end{aligned}$$

After all, any progress in mathematics is being made by reducing new problem situations—using the structural properties—to simpler problem situations which have already been mastered. This is as true on the Ph.D. level as it is in the 1st grade. We must make the most use of this feature in our elementary teaching approaches.

The distributive property also helps establish the order of opera-

tions. While $(2+3) \times 4 = 20$, $2+3 \times 4 = 14$, so that repeated addition (multiplication) precedes simple addition, regardless of the written order.

Further use is made of the distributive and commutative properties in deriving the products of $1 \times n$ and of $0 \times n$. Of course, such an elementary approach has to be informal and inductive. For example

$$\begin{array}{ll}
 4 \times 2 = 2 \times 4 & \text{commutativity of mult.} \\
 4 \times 2 = 4 + 4 & \text{defin. of } 2 \times 4 \\
 4 \times (1+1) = 4 + 4 & 2 \text{ is replaced by } (1+1) \\
 4 \times 1 + 4 \times 1 = 4 + 4 & \text{distrib. property} \\
 4 \times 1 = 4 & \text{identities} \\
 1 \times 4 = 4 & \text{commutativity of mult.}
 \end{array}$$

Similarly we show that

$$\begin{array}{ll}
 4 \times 2 = 2 \times 4 & \\
 4 \times (2+0) = 4 \times 2 & \text{identity of addition} \\
 4 \times 2 + 4 \times 0 = 4 \times 2 & \text{distrib. property} \\
 4 \times 0 = 0 & \text{identity of addition} \\
 0 \times 4 = 0 & \text{commutativity of mult.}
 \end{array}$$

It should be mentioned that commutativity and associativity of multiplication follow from our definition of multiplication as "repeated addition."

Division is first presented as "repeated subtraction." Thus $20 \div 5$ is given meaning as "how many times can 5 be subtracted from 20?"

	20	The answer is obtained by simply carrying out the repeated subtractions as shown. All that is necessary to obtain the answer, is to count the number of subtractions or, rather, the number of minus signs used in the procedure. Since there occur 4 minus signs, this leads to the interpretation of $20 \div 5$: The quotient, 4, denotes the number of times that the divisor, 5, could be subtracted from the dividend, 20. As soon as this has been accomplished, remainder sets are studied. Again by informal induction we find that for any divisor, d , the remainder set contains all natural numbers from 1 to $d-1$ and zero.
1 subtr.	-5	
	15	
2 subtr.	-5	
	10	
3 subtr.	-5	
	5	
4 subtr.	-5	
	0	
	0	

In this connection it is shown immediately that division is the inverse operation of multiplication. A demonstration of this impor-

tant relation which can be grasped by very young learners is the following:

MULTIPLICATION

(repeated addition)

0

+5

5

+5

10

+5

15

+5

20

DIVISION

(repeated subtraction)

20

-5

15

-5

10

-5

5

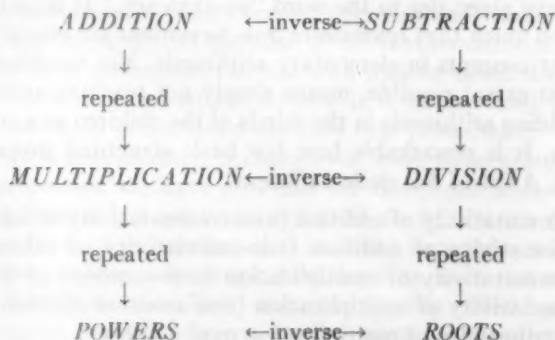
-5

0

When these two columns of numerals are examined, it is easily discovered that one is the inverse ("upside-down") of the other and that when this inversion is performed, addition becomes subtraction and subtraction becomes addition. Extended to the repeated use of these two operations, multiplication becomes division and division becomes multiplication.

The same point of "inverse operations" is also made and reinforced by extended use of the basic addition-subtraction and multiplication-division matrices.

On a somewhat higher level (grades 4, 5, 6) the process of "repeated operation" is further extended to produce "powers" and "roots." In this consistent procedure, powers are seen to be "repeated multiplication" and roots are interpreted as "repeated division." The complete elementary scheme of operations can be presented as follows:



While all of this is going on, very special emphasis is placed upon the multiples of 10 and upon the multiples of multiples of 10. When the concept of inequalities (the relations \neq , $<$, $>$) has been introduced, the written algorithms for multiplication and division are easily developed in a meaningful manner. Just to cite one example, consider the equation $324 \div 7 = \square$. Because of the inverse relationship between multiplication and division, this equation is equivalent to $324 = \square \times 7$. This leads to

$$280 < 324 < 350$$

$$40 \times 7 < 324 < 50 \times 7$$

It follows that the ten digit of the quotient must be 4. Furthermore, since $324 - 280 = 44$, the units digit of the quotient is now easily determined from the set of multiples of 7. The remainder follows with necessity; it must belong to the remainder set of 7 which is $\{0, 1, 2, 3, 4, 5, 6\}$.

It might be important to stress two fundamental points of procedure. (1) While the algorithms of the 4 fundamental operations are, of course, presented in the most convenient arrangement (e.g. column addition), great care is taken in presenting arithmetic as a language written horizontally, like English. It is only in the horizontal form that the basic structural properties can be made visible. (2) At every suitable occasion, the teacher emphasizes that all of arithmetic is concerned with *value* and with *form*. It is not sufficient for a child to learn all the answers to the "how much is . . ." questions; he must be made to be as much concerned with properties of form as with questions of value. When a 5 is replaced by $(2+3)$ or by $(4+1)$ or by $(7-2)$, it must be realized that all these expressions represent different forms for the same value 5. *Changes of form while the values remain equal* are one of the main concerns of elementary mathematics. Changes of form are also called "transformations" and equal values have given rise to the word "equivalence." It is certainly not saying too much that *equivalence transformations* are one of the most important concepts in elementary arithmetic. Not teaching them to the fullest extent possible, means simply not teaching arithmetic!

In building arithmetic in the minds of the children as a continuous structure, it is remarkable how few basic structural properties are involved. A list of 8 is quite sufficient:

1. Commutativity of addition (non-commutativity of subtraction)
2. Associativity of addition (non-associativity of subtraction)
3. Commutativity of multiplication (non-commut. of division)
4. Associativity of multiplication (non-assoc. of division)
5. Distributivity of multiplication over addition

6. Set N is closed under addition and multiplication (but not under subtraction and division).
7. The identity element of addition.
8. The identity element of multiplication.

This is really *all* that is needed for a mathematically acceptable approach to the teaching of arithmetic. In form of a comprehensive scheme, one might write

Operation	Commutative	Associative	Distributive	Identity	Inverse	Closure
Addition	Yes	Yes		0	$-a$	N: yes I: yes R: yes
Subtraction	No	No		(0)	$(+a)$	N: no I: yes R: yes
Multiplication	Yes	Yes	over addition and subtraction	1	$\frac{1}{a}$	N: yes I: yes R: yes
Division	No	No	Yes, when it follows addition or subtraction	1	a	N: no I: no R: yes (except by 0)

The Arithmetic on the levels of the upper elementary grades is merely a consistent and systematic extension of the operational and structural principles developed on the lower levels. Gradually the structural properties become more formalized until an elementary approach to "arithmetical proof" is within reach. If it were required to state the fundamental purpose of mathematics—its justification to exist, so to speak—in one short sentence, I would say without a moment's hesitation, risking oversimplification and misunderstanding, that the fundamental purpose of all mathematics is to *make proof*. It is in its continuous concern with making proof that mathematics reveals to us its structure, how it is made,—and it is here that the structural properties come fully into prominence.

But there is still another, perhaps even more elementary purpose to these properties. We have seen that set N is closed under addition and multiplication but not under subtraction and division. Thus the need arises for a set of numbers that is closed also under subtraction and division. Taking subtraction first, we introduce the set of the Integers ("whole numbers") or, as it is frequently called by its more complete name, the set of the positive and negative integers and zero.

This extended set, denoted as set I, is introduced in the form of a mathematical model, known to most people as the "number line." Because of the structured and systematic way in which we have built elementary arithmetic thus far, we now no longer need to tell our students that "minus times minus is plus" but make them prove why this has to be so.

This attitude toward proof leads gradually to the use of more general forms of numbers and to the "discovery" of patterns like arithmetic progressions and other elementary number series.

Primes and composites are presented along with a study of divisibility. The elementary number functions of the Least Common Multiple (LCM) and the Greatest Common Divisor (GCD) are obtained in terms of powers of the prime factors.

An elementary program of "construction geometry" which started at midterm in the first grade and which ran simultaneously to the arithmetical program, enables our students by the end of the 3rd grade to divide a given straight line segment into any number of equal subsegments. When such constructions are applied to the number line model of set I, fractional numbers are formally introduced as names and marks for the subdivisions. In this first formal approach to fractional numbers the fundamental concept is based upon the operation of division. The approach by means of "ordered pairs" of integers is left to the 7th and 8th grades. All operations with fractional numbers are first introduced from the viewpoint of equivalence. Abbreviated algorithms are introduced after the basic concepts have been grasped and as the need for them arises.

Prime factors are used in the reduction of fractional numbers and in finding least common denominators. Terminating and periodic decimals are presented as special forms of fractional numbers. In review it is shown that the fundamental structural properties which were first elaborated in set *N* apply—with some modifications and extensions—also to sets I and *Ra* (the set of the Rational numbers).

With such a preparation and structural overall view of elementary arithmetic we find our students well prepared to enter the mathematics of the real numbers.

EARTH'S EQUATOR FOUND EGG-SHAPED, NOT CIRCULAR

The earth's equator is egg-shaped, not circular, an astronomer has found.

Imre G. Izsak, astronomer at the Smithsonian Astrophysical Observatory, Cambridge, Mass., used high precision photographs taken by the Baker-Nunn satellite tracking cameras to discover that the equator is elliptical.

He determined the equatorial diameter is about 1,400 feet longer from a point in the Atlantic just off the eastern tip of Brazil across to a point near the Admiralty Islands above eastern Australia than the diameter from a point on the equator below Southern California across to a point below Iran.

Notes on the "Cape Canaveral" Type Activity

Bowman C. Collins

Lick-Wilmerding High School, San Francisco, California

While there is current disagreement about the value of negative reinforcement, there is general consensus that we learn by being rewarded.¹ Recently, the author briefly described a method used in teaching a beginning college physics laboratory period, the procedure featuring a vivid variety of "learning feedback."² In this paper, we describe an activity illustrating the method.³

MISSILES—GOOD AND BAD

Unsuccessful missile shots, particularly several years ago, provided the public with spectacular apparent evidence of "human error." Of course, *many* things can go wrong before and after a missile launching. Yet, the two-valued result of the visible test, "succeed or fail," furnishes a clear evaluation (at least to on-lookers) of the perfection attained by the missile technicians.

Now, "failures" are also an expected part of the stages leading up to significant research. The original idea, as we know, usually evolves through a multitude of "wrong turns," "mistakes," "repeats," and "checks" before the final laboratory report or paper is written. We are concerned here with the contrasts between "failures" in initial and intermediate stages of *research work*, and "failures" in all stages of a three hour laboratory period.

TEACHING LABORATORY WORK AT IVY

It is of interest to compare the above types of "failures" to those occurring in the undergraduate physics laboratories (by students) at imaginary Ivy College. For the most part, "failures and errors" do *not* often happen in the simple "experiments" here. After all, a dedicated storeroom staff has well-assigned commercial equipment to pass out each week. All classes know that this equipment will give the right (e.g., Handbook) answer. Of course, slide rule errors can be made; but the students in a lab section check each other. The Laboratory Manual, containing the "experiments," indicates *exactly* what must be done to finish on time.

What kinds of "failures" and "errors" are made by graduate students at Ivy? Here we find the trials and tribulations common to graduate students, anywhere; here we find the equipment that will never work when first plugged in, the frustrations of late-at-night leak hunting, the equipment that is "glued" together in the initial stages. Here we find coincidence counters, not made in heaven, that will not work instantly even when the thesis advisors have con-

structed them. Here we find, in fact, *actual* experimental work.

A graduate student said, "I never knew what an 'experiment' was until I began my own work here. I thought it was verifying something when you knew *exactly* what you were verifying." The Unabridged Webster's New International Dictionary⁴ can remind us of what an "experiment" is: "EXPERIMENT . . . , n . . . 1. A trial or special observation made to confirm or disprove something doubtful, esp. one under conditions determined by the experimenter . . . 2. The action of trying or testing. . . ." It is clear that, whatever is done in Laboratory Experiments 1A-50B, by undergraduates at Ivy, the work is not experimental in the sense of Webster's.

The graduate students at Ivy help run the Upper division Laboratories. Juniors in Physics, for example, are aided in doing the beautiful Millikan Oil Drop Experiment afternoons from 3 P.M. to 5 P.M. (The class starts at 2 P.M., but an hour is always used to explain the Laboratory Manual.) The juniors find the charge on the electron in about two hours, always finishing by 5 P.M., sometimes earlier. They feel a justifiable sense of accomplishment. First becoming interested in this vital physical constant at 2 P.M., they enjoy looking through the microscopes (set up before-hand) and manipulating the rheostats (set up before-hand).

Prof. Robert A. Millikan first became interested in the elemental charge of the electron in 1907 or earlier. He was then about 42 years old. A first paper explained his method; he made "original mistakes and errors" by using water and alcohol to form water droplets, instead of *oil*. Having no laboratory manual, and using self-designed equipment, he published his definitive work in 1911.⁵

Over the years, Prof. Millikan must have had a variety of feelings, a variety of frustrations and hopes, all known to those probing the unknown without a laboratory manual. What feelings do the undergraduates at Ivy have when they are in their laboratory courses?

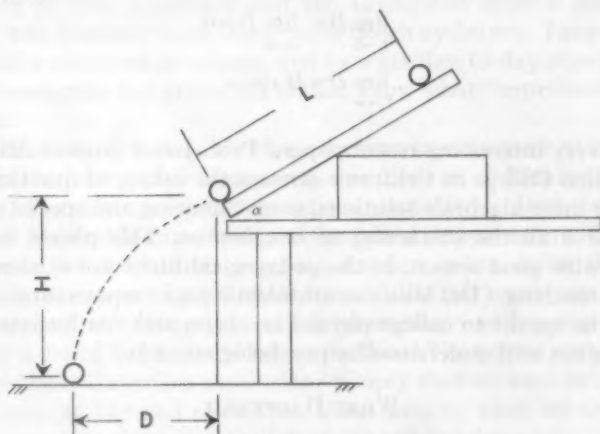
Primarily, they have a feeling of faith. This faith is in the preliminary hour-long explanation, the time-tested laboratory equipment, the fine Laboratory Manual, and the past glories of finishing early (sometimes at 4:30 P.M.).

Would the Cape Canaveral Method be something to try in undergraduate labs at Ivy? The author does not know. Perhaps there is value in mere manipulation of precision apparatus, rather than any kind of a search for the unknown which might induce experimental anxiety in Ivy undergraduates. It is comforting to know, some say, that things will work out, come what may (e.g., misunderstanding the Laboratory Manual, etc.) by the end of the period. However, we used the Method several times on the junior college level, giving respite from more conventional experiments. Intense student enthusiasm resulted.⁶

THE METHOD

The bizarre title, chosen advisedly, suggests similarities between tensions of students, when the method is used, and tensions of real experimenters (without quotation marks) at Cape Canavarel, for example. In a "Cape Canavarel Experiment," small groups may fail at the end of the period; in Florida, the experimenters may also "fail." The Method involves four steps:

1. An Experimental Problem is proposed; exact directions are *not* given.
2. The small groups take measurements and perform needed (as they see it) calculations; they arrive at a preliminary answer.
3. The groups check and re-check; they prepare their set-ups for "launching" by the instructor.
4. The instructor "fires" the set-up of each group as all the class look on; a single error by a group should produce a problem failure, or "dud," easily visible.



THE HIGH DIVING BALL BEARING

On each table: a precision plank, used as an inclined plane; on the front table: miscellaneous large ball bearings, calipers, micrometers, meter sticks, scotch tape, stop watches, plumb bobs, rheostats, ammeters, and Force Table Experiment equipment.

The Instructions: "We have talked about the acceleration of the c.g. of a sphere which *rolls* down an inclined plane and about freely falling bodies, neglecting air friction. Suppose I release your ball bearing at a point you specify. Where will it hit the floor near your bench? Use any equipment you wish, both here and in the back room. Some of this array may be useless for what you want to do."

All groups began within two minutes. Each group had different initial conditions for the path of their ball bearing; their spheres would later strike the floor (hopefully) at a line on a sheet of plain paper scotch-taped to the floor. We proposed, also, the problem of finding the general expression for D :

$$D = -(5/7)(L \sin \alpha \sin 2\alpha) \\ + (1/7)(25L^2 \sin^2 \alpha \sin^2 2\alpha + 140LH \sin \alpha \cos^2 \alpha)^{1/2}$$

A large protractor was available. We showed later that using trigonometry to get the angle, α , is a preferred procedure; a simple total differentiation of the arc-tangent function, and experimental estimation of the experimental differentials of the two sides of the right triangle involved, delimits $\Delta\alpha$.

Many writers have pointed out the satisfaction obtained when an investigator can check a formula using limiting and special cases. When such checking agrees with physical considerations, we have partial "inductive" proof that the formula may be correct. A similar satisfaction is obtained by examining the formula for D :

$$\lim_{L \rightarrow 0} D = \lim_{\alpha \rightarrow 0} D = 0$$

$$\lim_{L \rightarrow \infty} D = H \cot \alpha$$

In a very interesting recent paper,⁷ Prof. Julius Sumner Miller, of El Camino College in California stresses the asking of questions. He calls for more algebraic solutions, more "limiting and special cases," and above all the *awakening of imagination*. This phrase is often found, with good reason, in the pedagogical literature of *elementary science teaching*. (Dr. Miller's enthusiastic paper repays careful reading for he speaks to college physics teachers; and "enthusiasm" is a variable not well understood by psychologists at Ivy.)

WHAT HAPPENED

The instructor used a simple device, near the end of the period 'to release the ball bearing of each group. The first group was made up of three outstanding students in the lecture part of the course; their ball bearing, with the class looking on, missed not only their line but the paper itself. The class gasped—a dud!

The second group was made up of two hard-working students, students in the "territory of anguish," between a B and a C in Lecture. After their ball bearing was released, it struck their paper clearly near the line. The instructor detached the scotch tape and held up the paper. A crater-mark, about $\frac{1}{2}$ mm. across, was seen by all to be about 1 mm. from the line, on the short side. A complete success!

The class cheered. Whatever the phrase, "positive re-inforcement," may mean in an operational sense, it was present then in the class. Of nine groups that day, six were successful, or nearly so, and three got a C for effort. Most of the Lab period had been spent on the problem, not on explanations. The floor papers served as reports.

Other questions came up. What about D as a function of the angle, α ? Is there a maximum range for a given L and H ? What happens if the angle, α , is greater than 45° ? How can we take rolling friction into account? We considered these questions and others later in lecture.

CONCLUSIONS

The question of exactly what is being attempted in the Ivy three hour laboratory periods is still an open one. It is open elsewhere. Undergraduates at Ivy are often bored by following orders and finishing identical "experiments" by 4:45 P.M. Yet, literature on Great Moments of Science excites them. They actually *feel* the almost unbearable tensions underneath the Stadium at Chicago, in 1940, when the first atomic pile was about to go critical. They *feel* the elations of Prof. Lawrence and Dr. Livingston when a first feeble beam was obtained from their crude bench cyclotron. Tangential to the real excitement of science, and to what day-to-day experimentation means, the Ivy graduates do not know what "experimentation" means.

As teachers, is it possible that we communicate some of *our* boredom in the laboratory? Here comes one more set of Identical Experiments, identical except for neatness variations, deviations from explicit Manual Instructions, and careless slide rule errors. What can go wrong, what unusual thing can happen, when doing the Force Table Experiment? As 100 students work on this experiment, in different rooms, they *know* they will finish on time—with perfect results. If only a Force Table would fall to the floor! The fearful racket might relieve the tedium. Our conclusion? Simply that we need to ask more questions, at Ivy and elsewhere, about exactly what we are trying to do in science "experiments" done in traditional ways.⁸

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7. MILLER, JULIUS SUMNER, "It Is Important to Know What Questions to Ask," *American Journal of Physics*, 28, Jan., 1960, p. 38.
8. Many philosophers have expressed the view that it is more vital to ask significant questions than to seek easy answers. One often sees this view in the writings of Lord Bertrand Russell and also among writers of the Vienna Circle.

Note on Synthetic Division

R. F. Graesser

University of Arizona, Tucson, Arizona

Synthetic division is usually explained by successively modifying the steps in the division of polynomials. This explanation reminds one of the fish dealer who wanted a neon sign to announce his business. Finding too costly a sign with "Fresh Fish for Sale Here," he decided to eliminate the word "Fresh" since no other kind of fish would be offered for sale. But the sign was still too expensive so that he eliminated "Here" because such a sign would only be displayed where fish were sold. Continuing in this manner, he finally ended with the sign "Fish." The following is a variation from this usual explanation of synthetic division.

Let us first consider a special case. Carrying out the synthetic division process with $x^3 - 5x^2 + 7x + 4$ as a dividend and $x - 3$ as a divisor, we have

$$\begin{array}{r|rrrr} 1 & -5 & 7 & 4 & \\ & 3 & -6 & 3 & \\ \hline & 1 & -2 & 1 & 7 \end{array}$$

We wish to prove that $x^2 - 2x + 1$ is the quotient and 7 is the remainder. We can do this by proving that $(x^2 - 2x + 1)(x - 3) + 7 = x^3 - 5x^2 + 7x + 4$.

Now apply this method to the general case starting with the dividend $a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \dots + a_{n-1}x + a_n$ and the divisor $x - r$. Synthetic division then gives us

$$\begin{array}{ccccccc} & a_0 & a_1 & a_2 & & a_{n-1} & a_n \\ & & & & & & \\ \hline & a_0r & (a_0r^2 + a_1r) & \dots & (a_0r^{n-1} + a_1r^{n-2} + \dots + a_{n-2}r) & (a_0r^n + a_1r^{n-1} + \dots + a_{n-1}r) & \\ a_0 & (a_0r + a_1) & (a_0r^2 + a_1r + a_2) & \dots & (a_0r^{n-1} + a_1r^{n-2} + \dots + a_{n-2}r + a_{n-1}) & (a_0r^n + a_1r^{n-1} + \dots + a_{n-1}r + a_n) & \end{array}$$

We wish to prove that

$$a_0x^{n-1} + (a_0r + a_1)x^{n-2} + (a_0r^2 + a_1r + a_2)x^{n-3} + \dots + (a_0r^{n-1} + a_1r^{n-2} + \dots + a_{n-2}r + a_{n-1}) \quad (1)$$

is the quotient, and

$$a_0r^n + a_1r^{n-1} + \dots + a_{n-1}r + a_n \quad (2)$$

is the remainder. To do this, we multiply (1) by $x - r$ and add (2) to the result. The work is as follows:

$$\begin{array}{r} a_0x^{n-1} + (a_0r + a_1)x^{n-2} + (a_0r^2 + a_1r + a_2)x^{n-3} + \dots + (a_0r^{n-1} + a_1r^{n-2} + \dots + a_{n-2}r + a_{n-1}) \\ \hline x - r \\ \hline a_0x^n + (a_0r + a_1)x^{n-1} + (a_1r^2 + a_1r + a_2)x^{n-2} + \dots + (a_0r^{n-2} + a_1r^{n-3} + \dots + a_{n-2}r + a_{n-1})x \\ - a_0rx^{n-1} - (a_0r + a_1)rx^{n-2} - \dots - (a_0r^{n-2} + a_1r^{n-3} + \dots + a_{n-2}r + a_{n-1})r \\ \hline a_0x^n + a_1x^{n-1} + \dots + a_{n-1}x + \dots - (a_0r^{n-1} + a_1r^{n-2} + \dots + a_{n-1}r) \\ \hline (a_0r^n + a_1r^{n-1} + \dots + a_{n-1}r + a_n) \\ \hline a_0r^n + a_1r^{n-1} + \dots + a_{n-1}r + a_n \end{array}$$

New Books for the High School Science Shelf

Fourth Series: 1959-1960*

Louis Panush

Mackenzie High School, Detroit, Michigan

The growing interest and concern of young people, their parents and teachers with and about science and the rise of science to a prominent position in the total school curriculum has brought about an almost unprecedented demand for good books on scientific and technical subjects. This demand is being met, to a large extent, with imagination and understanding by authors and publishers with the publications of hundreds of better-than-average, often excellent, informative and up-to-date books on and about science which meet the interests and needs of all kinds of readers. Many of the books, published in the last two years, show evidence of higher standards of quality and production reflecting the growing sense of responsibility of authors and publishers to present articulate, accurate, authoritative, well-produced and illustrated accounts of scientific knowledge, contributions, research and advances in almost all areas of science.

Science books represent an important way of providing knowledge of basic facts and principles; they answer children's questions about the physical and biological world they live in and provoke further questions and, subsequently, additional reading; they stimulate experimentation and research; they provide materials for extracurricular reports and activities; they inspire; they evoke understanding and help establish an appreciation for learning and for the scientists who contribute to man's knowledge and progress; they serve as sources of invaluable information in terms of the young people's interests and problems.

Whether or not the school library will have a good number of these science books on its shelves and keep on adding to it periodically depends to a very large extent upon the science teacher(s) in that school. Dr. Deason of the American Association for the Advancement of Science recommends that at least 20% of the school library collections be in science books. A survey of 1,000 representative high school libraries, as reported in *AAAS Bulletin*, showed an average of only 5.2 per cent in their collections.

It is really up to the science teacher(s), in the first place, rather than the responsibility of the librarian who lacks specific interest and knowledge, to keep up to date on what's new in science books and to

* The first series, for 1953, was published in *SCHOOL SCIENCE AND MATHEMATICS*, "New Books for the Science Shelf," LIV, (May, 1954), 371-376.

The second and third series were published in mimeographed form by the *Michigan Science Teachers Association* in 1956 and 1959, respectively, and sent to the members as one of the services of MST.

make the necessary recommendations for the purchase of new and desirable books for the library. It is also up to him to convince the administration and the librarian to set aside a definite sum in the library budget, for the annual purchase of a sufficient number of books on science, and recommend the books that he needs and wants, for only he can be the judge of what will be of greatest value and use to his students and to his classes.

This list was compiled and annotated for the purpose of helping the science teacher to make the best possible selection for the amount of money he will have available for the science shelf. It is recommended that the reference and advanced books be purchased with NDEA funds, and that the sum allocated in the library budget be used for the other books. Actually, most of the books in this list, are eligible for purchase under NDEA.

This list is far from being exhaustive; many more were published in the last two years. However, it contains many books which will give high school students, and their teachers too, hours of informative, worthwhile, stimulating and enjoyable reading experience. Reading a good science book, in addition to the textbook and reference volume, is an effective means of science instruction as it adds to the reader's functional scientific knowledge and gives him a better understanding and appreciation of the complex world he lives in. Our students should be encouraged to read.

The list is diversified. It has books in almost every area of science to meet the needs and interests of the mature and talented students as well as those of the general, average and slow reader. Abbreviations indicate the type of book, as follow:

s.a. —slow, average reader	adv.—advanced reader
g.av.r.—general, average reader	sp.r.—supplementary reading
a.av.r.—above average reader	Rf —reference
m. —mature	R —recommended
s.ab. —special ability	HR —highly recommended
s.i. —special interest	

A list of publishers and their addresses is appended.

ADVENTURE & EXPLORATION

MODERN ADVENTURES UNDER THE SEA, by Patrick Pringle. *Watts*. 1959. 240 pages. Illustrated. \$3.95.

The story of the men who go deep under the surface of the sea for the sake of adventure, in search of natural or earthly treasures, to do a specific underwater job, or to extend scientific knowledge. (g.av.r.)

DISCOVERER OF THE NORTH POLE, by Marie Peary Stafford. *Morrow*. 1959. 220 pages. Illustrated by W. Buehr. \$3.00.

The biography of Robert E. Peary who, in 1909, after twenty-five years of unceasing effort, became the first human being to reach the North Pole. Very easy reading for the general slow reader.

NAUTILUS 90 NORTH, by Commander William R. Anderson with Clay Blair Jr. *World*. 1959. Illustrated. 256 pages. \$3.95.

A dramatic account by the skipper of the first atomic submarine Nautilus of her epoch-making voyage across the North Pole under the Arctic ice pack in August, 1958. Cmdr. Anderson describes vividly life aboard the Nautilus, preparations for the voyage, the special problems of navigation that had to be overcome, and the exciting adventure itself. (g.av.r., HR)

THE WORLD OF THE PHARAOHS, by Hans Bauman. *Pantheon*. 1960. 256 pages. Illustrated. \$4.00.

The fabulous art and culture of ancient Egypt, as seen through the eyes of a young "explorer," told vividly in an handsomely illustrated story. 30 full-color photographs, as well as line drawings, add to make it an exciting narrative. (g.av.r.)

ADMIRAL BYRD OF ANTARCTICA, by Michael Gladych. *Messner*. 1960. 192 pages. \$2.95.

The exciting story of the man who flew over, explored and "opened up" millions of miles of the wilderness of the North Pole. (s.a.r.)

AVIATION—ROCKETRY—SPACE EXPLORATION

THE STORY OF FLIGHT, by John Lewellen and Irwin Shapiro. *Golden Press*. 1959. 98 pages. Illustrated by H. McNaught. \$3.95.

An elementary and colorful introduction to man's challenge of the sky presented in easy text and excellent illustrations. Each development is given no more than a two-page spread. Included are Leonardo's experiments, Montgolfier's balloons, the Zeppelin, Langley's aerodrome, the Wright brothers' achievements at Kitty Hawk, the planes of both world wars, and the jets, rockets and satellites of the space age. (s.a., g.av. r., R)

ROCKET ENCYCLOPEDIA ILLUSTRATED. Edited by John W. Herrick and Eric Burgess. *Aero*. 1959. 606 pages. \$12.50.

A valuable reference for those interested in all phases of rocketry: research, engineering, production and testing. The history, theory, developments and technology of rockets are listed, defined, described and illustrated in alphabetical order. (adv.)

THE ROCKET HANDBOOK FOR AMATEURS. Edited by Charles M. Parkin. *Day*. 1959. 306 pages. Illustrated. \$5.95.

Gives basic knowledge to the safe construction, testing and launching of model rockets, with special attention to safety rules. However, it is highly recommended that any work on rockets and the use of propellants should be under the strict supervision of responsible and adult authority. (Rf)

MEDICAL SCIENCE AND SPACE TRAVEL, by William A. Kinney. *Watts*. 1959. 150 pages. Illustrated. \$3.95.

Describes how today's flight surgeons, both in the air and in the laboratories, are working to meet the challenge of putting man into space, insuring his survival and returning him to earth unharmed. (g.av.r., R)

NEW DIMENSIONS OF FLIGHT, by Lewis Zarem. *Dutton*. 1959. 256 pages. Illustrated. \$4.50.

Explains the principles, concepts and vehicles of flight from faster-than sound airplanes to the conquest of space. Accurate information about supersonic aircraft and jet propulsion, nuclear engines, vertical take-off and landing airplanes, the various guided missiles—their control, guidance and propulsion, the research vehicles used in probing for the knowledge needed to advance flight in air and in space, and problems in space exploration, propulsion and vehicles. Profusely illustrated and written in clear and understandable language. (g.av., a.av.r.)

OUT OF THIS WORLD, by Dan Posin. *Popular Mechanics*. 1959. 180 pages. Illustrated. \$3.95.

This book is based on Dr. Posin's TV show "Out of This World" which he conducted and produced on CBS. In a delightful and informative manner he discusses the problems attendant to travel in space: physical, biological, and astronomical. Although presented in a popular style, it is authoritative and based on what is known to-date about the earth and the solar system. It is illustrated with the same drawings and calculations that he used on his TV presentations. (g.av., a.av.r.)

WAR FOR THE MOON, by Martin Caidin. *Dutton*. Illustrated. 1959. 258 pages. \$4.95.

An authoritative account of the U. S. and Soviet lunar probes from the initial planning to the firing of our first unsuccessful lunar probe in 1958; and from the deep-space probe Mechta, successfully launched into space by the Russians on January 2, 1959 to the U. S. hurling of the Pioneer IV payload past the moon and into solar orbit on March 3, 1959. Will give the interested reader an understanding of our efforts to explore the moon and the space beyond and the problems confronting us. (g.av.r., a.av., R)

THE SPACE ENCYCLOPEDIA. Edited by M. T. Bizony. *Dutton*. 1960. 288 pages. Illustrated. \$8.95.

A new and revised edition which has over 700 entries in the following areas: astronomy (sun, moon and planets, meteors and comets, the Milky Way and galaxies), cosmology, radio astronomy, guided missiles, rocketry and satellites, and space medicine. Full length articles are devoted to the major topics. All the terms are clearly defined and many are illustrated. (a.av., s.ab., adv., Rf)

AVIATION IN THE MODERN WORLD, by James V. Bernardo. *Dutton*. 1960. 352 pages. Illustrated. \$5.95.

The story of modern aviation, missiles, space vehicles, man's attempts to explore space, and the impact of same upon man and the society in which he lives. Contains much information on aviation and commerce, air transportation, space exploration, the principles and path of flight, and various career opportunities in the field of aviation. There is an extensive listing of selected materials for air-age education. (a.av. r., s.i., R)

THE ASTRONAUTS, by Martin Caidin. *Dutton*. 1960. 192 pages. Illustrated. \$3.95.

Describes the Mercury Project in great detail and tells about the seven American Astronauts, their qualifications, selection, training and preparation for orbital flight around the earth. The reader will share in the excitement of and tascination with our man-in-space program which will soon make a U. S. dream come true. (g.av.r., m., R)

ASTRONOMY & COSMOLOGY

ASTRONOMY, by Theodore G. Mehlin. *Wiley*. 1959. 392 pages. Illustrated. \$7.50.

An introductory college textbook in the fundamental facts, principles and theories of astronomy. The subject matter is presented logically and clearly and will give the student an understanding of and current knowledge about the astronomical universe. (a.av., s.ab., m., Rf, R)

BIOGRAPHY OF THE EARTH: Its Past, Present, and Future, by George Gamow. *Viking*. 1959. 242 pages. Illustrated. Paperbound. \$1.35.

A revised edition of a classic by Dr. Gamow which presents a fascinating "life history" of our planet and brings up-to-date, in terms of latest research, the theories of its origin and evolutionary development. (a.av., s.ab., m., Rf, HR)

THE KINGDOM OF THE SUN, by Isaac Asimov. *Abelard-Schuman*. 1960. 160 pages. Illustrated. \$3.00.

A very interesting and readable account of the momentous discoveries, from Babylonian observations to the end of World War I, which have helped in extending man's knowledge and understanding of the nature of the solar system. The contributions of the astronomers are described in terms of their impact and significance. (g.av.r., R)

THE MOON, by George Gamow. *Abelard-Schuman*. 1959. 144 pages. Illustrated by B. Tagawa. \$2.75.

This revised edition of a book first published in 1953 contains the most recent information about our nearest neighbor in space: its origin, surface features and landscape, orbit, gravitation, atmosphere, and the reality of a rocket to the moon. (g.av.r., R)

PLANET EARTH. See **EARTH SCIENCE**.

THE SLEEPWALKERS: A History of Man's Changing Vision of the Universe, by Arthur Koestler. *Macmillan*. 1959. 624 pages. Illustrated. \$6.50.

One of the important and articulate writers of today analyzes man's efforts to comprehend the nature of his universe in a history of cosmology from the days of the Babylonians to Newton. The major portion of this lucid and readable book is devoted to a discussion of the lives, works and accomplishments of the leading cosmologists of the 16th and 17th century: Copernicus, Kepler, Galileo, and Newton. The author calls them "sleepwalkers," men who stumbled their way to profound insights and "pushed mankind towards ever-enlarging horizons of enlightened understanding and ultimate truth." (m., s.ab.+i., R)

STARS: A Guide to Constellations, Sun, Moon, and Other Features of the Heavens, by Herbert S. Zim and Robert H. Baker. Revised edition. *Golden Press*. 1959. 160 pages. Illustrated by James J. Irving. Hardcover, \$2.50.

An outstanding authority on science education, a well-known writer on astronomy and a capable illustrator have combined their efforts to produce a colorful and informative guide for the student and layman who are interested and want to understand and enjoy what they see in the skies. (g.av.r., R)

THE SUN, by Karl Kiepenheuer. *University of Michigan Press*. 1959. 160 pages. Illustrated. Paperbound. \$1.95.

An authoritative summary of our knowledge about the solar system and what research tells us about the sun, its chemical composition, surface characteristics, solar phenomena and radiation, and man's dependence on it for energy, for weather and for the very existence of life on earth. (adv., m., Rf. HR)

OUR EARTH. See **EARTH SCIENCE**.

ASTRONOMY, by H. C. Kling. *Watts*. 1960. 256 pages. Illustrated by T. Maloney. \$4.95.

Presents the early history of astronomy, the development of the telescope and some of the newest astronomical tools, and some of the important discoveries by astronomers since Galileo. Discusses the standard topics of astronomy: the sun, the moon and eclipses, the planets, comets and meteors, the stars and star clusters, the Milky Way and the galaxies beyond, and considers the possibilities of space travel in terms of recent experiments with space satellites. (g.av.r., HR)

THE SKY IS OUR WINDOW, by Terry Maloney. *Sterling*. 1960. 128 pages. Illustrated. \$3.75.

An introduction to astronomy which treats a wide variety of astronomical subjects (earth, moon, planets, asteroids, meteors, comets, sun, solar system, the Milky Way, and the universe at large) with skill and accuracy. The many beautiful photographs and paintings add to the enjoyment of reading this informative book. (g.av.r., HR)

THE DOUBLE PLANET. See EARTH SCIENCE.

AMERICA'S FIRST WOMAN ASTRONOMER: MARIA MITCHELL. See BIOGRAPHY.

THE FASCINATING WORLD OF ASTRONOMY, by Robert S. Richardson. *McGraw-Hill*. 1960. 272 pages. Illustrated. \$5.95.

An introduction to astronomy presented in a question-and-answer manner. Covers all the standard topics: the sun, the moon, planets, asteroids, stars, galaxies—their physical characteristics, motions, relationships, present-day research, etc. Also describes the work of astronomers and the instruments they use. Informal in style, very informative in content, and excellently illustrated. (g.av., a.av., HR)

NINE PLANETS: ASTRONOMY FOR THE SPACE AGE, by Alan E. Nourse. *Harper*. 1960. 296 pages. Illustrated by M. Hunter. \$5.95.

Describes the nine planets of our solar system, their satellites and their sun on the basis of known fact and present-day advances in astronomical knowledge. Speculates reasonably on what man may expect to find in the course of his exploration of the solar system and considers the question why man wants to explore space, what he is looking for, and what his quest and findings may eventually mean to him. (a.av.r., m., adv., R)

AND THERE WAS LIGHT, by Rudolf Thiel. *New American Library*. 1960. 384 pages. Illustrated. Paperbound. 75¢.

A comprehensive history of astronomy from ancient times to present-day theories and advances in astronomical knowledge and the areas of astrochemistry, radio astronomy and space satellites. (a.av., adv.)

THE OSCILLATING UNIVERSE, by Ernest J. Opik. *New American Library*. 1960. 144 pages. Paperbound. 50¢.

A collection of essays on astronomy, including such topics as the origin of the earth and life on it, the moon, the sun and the solar system, solar phenomena, the planets, stellar systems, and current cosmological theories. (a.av., adv., s.ab.+i.)

ATOMICS & NUCLEONICS

FROM HIROSHIMA TO THE MOON, by Daniel Lang. *Simon & Schuster*. 1959. 496 pages. \$5.95.

A journalist's account (Mr. Lang is a staff member of the *New Yorker*) of the many men and women who played a part in the drama of the dawn of the atomic age and the aftermath of the "bomb." Included in the story are scientists, military leaders, AEC commissioners, uranium prospectors, space engineers, and others. Enjoyable and informative reading on behind-the-scenes of scientific history-in-the-making. (g.av. r., a.av.)

FUNDAMENTALS OF NUCLEAR ENERGY AND POWER REACTORS, by Henry Jacobowitz. *Rider*. 1959. 144 pages. Illustrated. \$2.95.

Explains the basics of atomic energy and nuclear structure; discusses the essentials of nuclear fission and the chain reaction; and the construction, principles of operation and the power output of nuclear reactors and power plants. (s.ab., adv. Rf)

RADIOACTIVE ISOTOPES IN CLINICAL PRACTICE. See PHYSICS.

THE NEUTRON STORY. THE RESTLESS ATOM. ACCELERATORS. See PHYSICS.

MAN-MADE SUN: The Story of Zeta, by J. D. Dukes. *Abelard-Schuman*. 1959. 186 pages. Illustrated. \$2.75.

A readable account of the efforts of the British scientists to release the tremendous energy locked up in the nuclei of atoms in a controllable and orderly fashion

by the fusion of deuterium. For fusion, atoms have to be heated to temperatures of tens or hundreds of millions of degrees. This was the purpose of *Zeta* (zero-energy, thermonuclear assembly) which achieved and maintained temperatures of a few million degrees in deuterium gas. This may lead towards making a useful, controlled, thermonuclear reactor for the production of power from fusion. (s.ab., adv.)

BIOGRAPHY

EDISON, by Matthew Josephson. *McGraw-Hill*. 1959. 514 pages. Illustrated. \$6.95.

A comprehensive and authoritative biography of the great inventor based on original materials from the Edison Library in West Orange, N. J. Every phase of his life is covered and is woven into a sympathetic story of his development from humble beginnings to a world-famous celebrity. All of his inventions and contributions are described: the carbon microphone, the electric lighting system, the phonograph, the motion picture camera, and many others. There is a lot to read, but it is worth reading in order to get an understanding of Edison as a man and a scientist. (a.av., adv., s.ab., R)

ELECTRICAL GENIUS: Nicola Tesla, by Arthur J. Beckhard. *Messner*. 1959. 192 pages. \$2.95.

The life story of the inventor of the alternating current motor, the telephone amplifier, the arc light, the Tesla coil, the magnifying transmitter, and whose 110 patents (of the 212 granted him) are in essential use today. (s.a., g.av.r., R)

LOUIS PASTEUR: Fighting Hero of Science, by Madeleine P. Grant. *Whittlesey House*. 1959. 220 pages. Illustrated \$3.25.

An absorbing biography of Pasteur in which his life story is interwoven with his researches and achievements in stereochemistry, bacteriology, the silk industry, agriculture, medicine and public health. (s.a.r.)

MAN OF COURAGE: The Story of Dr. Edward L. Trudeau, by Kathryn E. Harrod. *Messner*. 1959. 192 pages. \$2.95.

The dramatic life story of Dr. Trudeau who dedicated his life to fighting the most fearful disease of the 19th century, tuberculosis, and who founded America's first TB sanitarium at Saranac Lake. (s.a., g.av.r.)

GREGOR MENDEL: Father of the Science of Genetics, by Harry Sootin. *Vanguard*. 1959. 224 pages. \$3.00.

A warm-hearted, simply written biography of Mendel who experimented with peas in a monastery garden and discovered the laws of heredity. (s.a.r., R)

DISCOVERER OF THE NORTH POLE. See ADVENTURE & EXPLORATION.

ADMIRAL BYRD OF ANTARCTICA. See ADVENTURE & EXPLORATION.

THE DOCTOR WHO DARED, by Iris Noble. *Messner*. 1959. 192 pages. \$2.95.

A warm portrait of Dr. William Osler, a distinguished medical pioneer and a foremost pathologist and leading diagnostician of his time whose ideas, laboratory and demonstration techniques, hospital practices and teaching methods greatly influenced medical progress. (s.a., g.av.r., R)

THE DISCOVERER OF INSULIN, by I. E. Levine. *Messner*. 1959. 192 pages. \$2.95.

The life story of Dr. Frederick Banting and his search, discovery and perfection of insulin. (s.a.r., R)

ALEXANDER VON HUMBOLDT, by M. A. Thomas. *Pantheon*. 1960. 192 pages. Illustrated. \$3.50.

Scientist, explorer and adventurer, Alexander von Humboldt (1769-1859)

trekked through the jungles and scaled mountains in South America to make many discoveries. As a pioneer in natural science he has had currents, a bay, a glacier, towns, parks and mountains named after him. Late in life, he wrote the *Cosmos*, the story of the universe as he understood it. (s.a.r., R)

CONQUEROR OF SMALLPOX: Dr. Edward Jenner. *Messner*. 1960. 192 pages. \$2.95.

The story of one of the greatest disease fighters of the 18th century who by his discovery of a vaccine for smallpox "rescued mankind from one of history's most terrible scourges." (s.a.r., R)

ELIZABETH GARRETT, M.D., by Jo Manton. *Abelard-Schuman*. 1960. 160 pages. \$3.00.

The biography of England's first woman doctor who, following the example of her American counterpart, Elizabeth Blackwell, overcame rebuffs and discouragements to become her country's first woman medical student and eventually its first woman practicing physician. (g.av.r., R)

12 PIONEERS OF SCIENCE, by Harry Sootin. *Vanguard*. 1960. 254 pages. Illustrated. \$3.00.

Biographical profiles and descriptions of the outstanding discoveries and the significance of the work of twelve notable scientists: Pascal, Scheele, Volta, Davy, Henry, Darwin, Adams (discovery of Neptune), Metchnikoff (phagocytosis), Hertz, Du Bois (discovery of the Java man), Langley, and Becquerel. (s.a., g.a.r., R)

FAMOUS MEN OF SCIENCE, by Sarah K. Bolton. *Crowell*. 1960. 326 pages. \$3.50.

A classic collection of biographies of some of the world's outstanding scientists, revised and brought up-to-date by the inclusion of those who have made their mark in the last two decades of the twentieth century. Included are Copernicus, Galileo, Newton, Herschel, Faraday, Kelvin, Edison, the Curies, Marconi, Burbank, Reed, the Comptons, Fleming, Einstein, Urey, Mark, Fermi, Salk, Lee and Yang. (s.a., g.av.r., HR)

CANCER, COCAINE AND COURAGE, by Arthur J. Beckhard and William D. Crane. *Messner*. 1960. 192 pages. \$2.95.

The fascinating life history of Dr. William Halstead who was the first physician in America to practice aseptic surgery and who developed unique surgical techniques for breast cancer and hernia. (s.a., g.av.r.)

COPERNICUS, by Henry Thomas. *Messner*. 1960. 192 pages. \$2.95.

The story of the life and the dramatic achievements of the founder of modern astronomy. (s.a., g.av.r., R)

THE COURAGE OF DR. LISTER, by Iris Noble. *Messner*. 1960. 192 pages. \$2.95.

The romantic life story and exciting contributions of Dr. Joseph Lister who introduced the revolutionary principle of antiseptic surgery. (s.a., g.av.r., R)

AMERICA'S FIRST WOMAN ASTRONOMER, by Rachel Baker and Janna Baker Merlen. *Messner*. 1960. 192 pages. \$2.95.

Maria Mitchell, the heroine of this lively biography, was the first Professor of Astronomy at Vassar and the first woman to be elected to the American Academy of Arts and Sciences. (s.a., g.av.r., R)

SCIENTISTS BEHIND THE INVENTORS, by Roger Burlingame. *Harcourt, Brace*. 1960. \$3.25.

The thrill of pure scientific research is communicated to the reader through the lives and discoveries of Black, Silliman, Henry, Pasteur, Pupin, the Curies, and Einstein. The author shows how their work and inspiration have been a major factor in the development of a number of important inventions. (g.av.r., R)

BIOLOGY

Anatomy & Physiology

THE HUMAN BODY: What It Does and How It Works, by Mitchell Wilson. *Golden Press*. 1959. 140 pages. Illustrated by C. De Witt. \$4.95.

A very informative and beautifully illustrated text which introduces the reader to human anatomy and physiology. (a.s., g.av.r., HR)

FUNCTION OF THE HUMAN BODY, by Arthur C. Guyton. *Saunders*. 1959. 584 pages. Illustrated. \$7.50.

Presents clearly and stresses adequately the basic principles of human physiology. Draws on classical and animal experiments to illustrate some of these principles and on selected human abnormalities to teach applied physiology. This comprehensive, although not detailed, text does not require an extensive background of biology, physics or chemistry. (adv., m., Rf, R)

MAN AND HIS BODY, by Benjamin F. Miller and Ruth Goode. *Simon & Schuster*. 1960. 374 pages. Illustrated. \$5.95.

Describes the wonders of the human body, the structure and working of each part as it functions either as an organ or as a vital component of the circulatory, respiratory, digestive, excretory, secretory, nervous and reproductive systems. There is an excitement and fascination in the way the authors present the subject, as they unfold the complex and efficient mechanism of the human body. (a.av., adv., m., HR)

Animals

ANIMAL CAMOUFLAGE, by Adolph Portman. *University of Michigan Press*. 1959. 112 pages. Illustrated. Paperbound. \$1.95.

Describes the techniques of animal camouflage, explains how and why it works, and what is its role in the evolution of the species. Nature's skill at instinctive disguise is shown by means of markings that blend with the landscape, concealment of contours, through masking, resemblance and mimicry, concealing colors and adaptive color changes, and other effective ways vividly described in this brief volume. (s.ab. + i., m., R)

ANIMAL LIFE, by Lorus J. and Margery Milne. *Prentice-Hall*. 1959. 368 pages. Illustrated. \$6.95.

Covers the general principles, concepts and facts of the general zoology course. Among the topics discussed are animal phyla and their economic importance, cellular structure and composition, energy relations, the chordates, the invertebrate phyla, the problems of growth and development, heredity, adaptations and ecological relationships, life in the past, and the problems life presents as we look forward in the future. (a.av., adv., sp.r., Rf, R)

THE BOYS BOOK OF TURTLES AND LIZARDS, by Percy A. Morris. *Ronald*. 1959. 230 pages. Illustrated. \$4.50.

A guide to the turtles and lizards to be found in the United States, giving their identifying features, known geographic range, size, habitat, sources of food, breeding habits, natural enemies, etc. Also gives information on how to collect them and how to take care of specimens. Illustrated with photos taken in the animals' natural surroundings. (g.av.r., s.i., sp. r.)

DEMON OF THE NORTH, by Peter Krott. *Knopf*. 1959. 264 pages. Translated from the German by E. Fitzgerald. Illustrated. \$5.00.

An Austrian naturalist and animal dealer reports on his study of the wolverine, an elusive and ill-reputed animal of the northern European forests. His account dispels the myth of the animal's wickedness, tells about its feeding and hunting habits and life in the natural environment. The story also includes other animals, such as the lynx, swans and moose which Mr. Krott brought to his wild-life pre-

serve near Helsinki, Finland. A delightfully informative book about an animal which is the state animal of Michigan. (a.av., s.i., m.)

ELEPHANTS, by Richard Carrington. *Basic Books*. 1959. 272 pages. Illustrated. \$5.00.

A documented account of the natural and evolutionary history of the elephant. Describes the elephant as an animal: its body and how it works, life and love among elephants, and their living relations. This is followed by the story of the elephant's origin and evolution in geologic time. There is also a discussion of elephant hunting, the use of the animal as a servant of man, for show and entertainment, and man's efforts to preserve and control the species. (a.av., adv. s.i., m.)

IN THEIR ELEMENT: The Story of Water Mammals, by Maurice Burton. *Abelard-Schuman*. 1960. 160 pages. Illustrated. \$3.00.

Amazing facts, brought to light by modern research, about some mammals who, in some stage of their history, changed over from land to water life. Among the animals described are the whales, seals, otters, river-horses and sea-cows, beavers, water rats, and the platypus. (g.av.r., adv., sp.r.)

ANIMAL GROWTH AND DEVELOPMENT, by Maurice Sussman. *Prentice-Hall*. 1960. 114 pages. Illustrated. Paperbound. \$1.50.

Discusses developmental phenomena from the life cycle of the single cell through the development and growth of the multicellular organism. (adv., sp.r., Rf. R)

ANIMAL PHYSIOLOGY, by Kurt Schmidt-Neilson. *Prentice-Hall*. 1960. 118 pages. Illustrated. Paperbound. \$1.50.

Takes up the general physical principles and life processes of animals: nutrition, respiration, circulation, excretion, movement, the nervous system., etc. (adv., sp. r., Rf, R)

ANIMAL CLOCKS AND COMPASSES, by Margaret O. Hyde. *Whittlesey House*. 1960. 160 pages. Illustrated. \$2.95.

Stories about animals who find their way on earth, the natural rhythms by which they live and travel, and the amazing sense of time and direction which they possess. Included among others are the strange habits of salmon, eels, birds, insects, and mammals. The student is provided with information and instructions on performing experiments at home with earthworms, frogs, drosophila, bird banding, etc. (s.a., g.av.r., R)

Anthropology

PEOPLE AND PLACES, by Margaret Mead. *World*. 1959. 320 pages. Illustrated by W. T. Mars and J. Fairservis. \$4.95.

A world-famous anthropologist presents an extremely readable and interesting introduction to the study of man. She explains what we know about all people and describes the diversified ways of living and cultures of five distinct groups—the Eskimo, the Indians of the Plains, the Ashanti of West Africa, the Minoans of Crete, and the Balinese. She touches upon the important problems of human relations and suggests steps which have to be taken for their solution. (s.a., g.av.r., HR)

THE STORY OF EARLY MAN, by H. E. L. Mellersh. *Viking*. 1960. 258 pages. Illustrated. \$4.50.

Traces the long, slow transition of man from food-gathering to hunting and agriculture. Discusses the development of language and cave art, the gathering of man into communities, the development of customs, beliefs and practices which modeled the human form and thought. An exciting history of man's

progress from prehistoric and/or primitive stages to the beginning of what we call human civilization. (a.av.r., s.i., m., R)

Birds

FEATHERS AND FLIGHT, by Clarence J. Hylander. *Macmillan*. 1959. 214 pages. Illustrated. \$3.95.

Describes the place of birds in the animal kingdom, the characteristics of birds "on the wing" (flight and navigation) and "at home" (feeding habits, courtship and nesting, family life, etc) and various kinds of water birds, birds of prey, game birds, perching birds, and small birds with unusual habits. (s.a., g.av.r., R)

Biochemistry

FROM CELL TO TEST TUBE, by Robert Warner Chambers and Alma Smith Payne. *Scribner's*. 1960. 216 pages. Illustrated. \$3.50.

An elementary introduction to biochemistry. Emphasizes the important biochemical concepts, describes some of the important experiments which established them, and tells of the practical applications of biochemical knowledge to modern-day living. Among the subjects discussed are the structure and composition of the cell, the role of enzymes, the chemistry of proteins, carbohydrates, fats, amino acids, hormones and vitamins, and the genetic importance of DNA. (g.av.r., HR)

Cytology

INSIDE THE LIVING CELL, by J. A. V. Butler. *Basic Books*. 1959. 176 pages. Illustrated. \$3.50.

Up-to-date information, presented in clear and readable language, on the structure of the cell, its various components and their function. Newest knowledge, as of the date of publication, based on the dramatic and far-reaching biological research which is going on in recent years, is presented on cell division, viruses, photosynthesis, the structure, mechanism and function of muscle and nerve cells, and the aging and death of cells. (a.av., adv., sp.r., R)

THE CELL, by Carl P. Swanson. *Prentice-Hall*. 1960. 114 pages. Illustrated. Paperbound. \$1.50.

Deals with the cell as the basic unit of biological structure and function and takes it through the processes of growth, differentiation, reproduction, and death. (adv., sp.r., Rf, R)

Ecology

FUNDAMENTALS OF ECOLOGY, by Eugene F. Odum. *Saunders*, 1959. 546 pages. Illustrated. \$7.50.

An introductory text to the science which is concerned especially with the biology of groups of organisms and with functional processes on the land, in the ocean, and in fresh water. Discusses such basic principles and concepts as habitat, biogeochemical cycles, the food chain, population, group and species properties. Emphasizes ecological applications with reference to natural resources, public health and welfare, radiation problems, and the human society. (a.v., adv., s.i., Rf)

Evolution

THE VOYAGE OF THE BEAGLE, by Charles Darwin. *Bantam Books*. 1959. 440 pages. Paperbound. 50¢.

THE VOYAGE OF THE BEAGLE, by Charles Darwin. Abridged and edited by Millicent E. Selsam. *Harper*. 1959. Illustrated by A. Ravioli. 326 pages. \$3.95.

The record of Darwin's experiences during the five years (1831-36) he sailed around the world as a naturalist on H.M.S. Beagle. The first book, an unabridged version, is for the mature and able student who wants to read the original

journals. The second book, less than one-half of the length of the original, is not only easier on the eye because of the very fine physical make-up but has a perceptive and illuminating introduction to each of the 21 chapters. The second can be read with understanding and profit by the average biology student. (HR)

THE LIFE AND LETTERS OF CHARLES DARWIN. Edited by Francis Darwin. *Basic Books*. 1959. Vol. I, 538 pages; Vol. II, 560 pages. Illustrated. Boxed, \$10.00.

In 1959 the world celebrated the 150th anniversary of Darwin's birth; it also celebrated the 100th anniversary of the publication of the "Origin of the Species by Means of Natural Selection." These volumes have been re-issued in recognition of the great event in the history of science. They contain Darwin's autobiography, his son's portrait of the family and reminiscences of his father's everyday life, and the scientist's voluminous correspondence with his great contemporaries in science. From these letters one may get a vivid portrayal of Darwin's life and work, his voyage on the *Beagle*, the "evolution" of the "Origin of the Species," the subsequent attacks, criticisms and defense, his "Descent of Man," and his habits, methods and personality. (avd., m., s.i.)

Genetics and Heredity

HUMAN HEREDITY, by Ashley Montagu. *World*. 398 pages Illustrated. \$5.00.

Presents what is known to-date of human heredity, based on recent studies and research. Emphasis is placed on genes, their structure and composition, and their function as units of heredity which determine physical features, resistance to disease, intellectual capacity, "racial" characteristics, etc. Has a very interesting chapter on the inherited disorders of man, a good glossary, and an extensive bibliography. (a.av., adv., s.i.)

PRINCIPLES OF GENETICS, by Eldon J. Gardner. *Wiley*. 1960. 368 pages. Illustrated. \$7.50.

This textbook for an introductory course in genetics begins with an explanation of what the science is all about, then traces its historical background from the classical work of Mendel. It takes up the concept of the gene, the mechanism of gene inheritance, sex chromosomes and sex linkage, and hormonal influences on gene action. Also discusses mutations, alleles and compound loci, the biochemical aspects of genes, physiological and developmental genetics, population genetics, operation of genetics in evolution, and the application of genetic principles in plant and animal breeding. (a.av., adv. Rf, R)

VIRUS, by Wolfhard Weidel. *University of Michigan Press*. 1959. 160 pages. Illustrated. Paperbound. \$1.95.

Tells how scientists found out what viruses are, how they behave and reproduce in living cells, how viruses are growing, experimented with and what knowledge is derived from this research, what makes a virus so treacherous, how it can be controlled, and the genetic information which is derived from virus research. (s.ab.+i., avd., m., HR)

AN OUTLINE OF CHEMICAL GENETICS, by Bernard S. Strauss. *Saunders*. 1960. 188 pages. Illustrated. \$5.00.

Discusses the genetic control of protein synthesis, the chemical nature and behavior of the hereditary material, DNA, the gene and its characteristics, the chemical nature of the mutation process, and the bio-chemical genetics of man. An excellent review of, and reference on, the present status of the science. (adv., m. Rf, R)

Insects

INSECT BUILDERS AND CRAFTSMEN, by Ross E. Hutchins. *Rand McNally*. 1959. 96 pages. Illustrated. \$2.95.

The author displays a special interest in unusual insect life which he describes and illustrates with remarkable black and white photographs in his second book on insects. After discussing the natural tools of certain insects and their skills, specific insect builders and craftsmen are presented, such as paper makers, carpenters and tailors, honey makers, mushroom growers, tree dwellers, and others. Also describes the homes which they build in clay, out of sticks and stones, under the prairie, etc. (s.a., g.av.r., R)

Microbiology

TEXTBOOK OF MICROBIOLOGY, by William Burrows, Richard J. Porter and James W. Moulder. *Saunders*. 1959. 17th edition. Illustrated. \$14.00.

This definitive college text in microbiology is recommended as an invaluable reference for both teacher and advanced, capable students in schools where the subject is offered in the science curriculum. The text presents the historical background of the subject, then discusses—among others—such topics as basic laboratory methods and procedures, the physical and chemical structure of the microbial cell, the growth and taxonomy of microorganisms, bacterial metabolism and the use of various agents in their control, specific microorganisms and the diseases they cause, and all phases of immunology. (s.ab., Rf)

Microscopy

NEW WORLD THROUGH THE MICROSCOPE, by Robert Disraeli, *Viking*. 1960. 176 pages. Illustrated. \$4.00.

One of the finest guides to the study of the invisible world with the aid of a microscope. Directions are given for finding specimens, mounting them, and how to use the microscope. Excellent black and white photos and microphotographs will aid in locating and understanding the structures and materials under investigation. These include insects (eggs, larvae, pupae, eyes, legs, antennae), protozoa, algae, fungi, roots, leaves, blood, cells, cloth, crystals, paper, and others. (g.av.r., sp.r., HR)

Medicine and Health

ESSENTIALS OF HEALTHIER LIVING, by Justus J. Schifferes. *Wiley*. 1960. 336 pages. Illustrated. \$5.50.

Discusses five major areas keyed to the interests and needs of adult students: personal health (the human body in action and at rest, improving personal appearance, food and nutrition, diet), education for family living (reproduction, birth of a baby, preparation for marriage), mental health (the unconscious mind, mental illness, alcohol and narcotics), health hazards (heart disease, cancer, communicable and other diseases), and community health (community health organizations, Public Health Service, W H O). (s.av.r., m., Rf)

CANCER, COCAINE AND COURAGE: The Story of Dr. Halstead. See BIOGRAPHY.

VIRUS HUNTERS, by Greer Williams. *Knopf*. 526 pages. Illustrated. \$5.95.

A very readable and informative account of the dramatic progress made in the never-ending war against diseases caused by viruses, the identification of the agents of yellow fever, polio, hepatitis, flu, and others. The work of the better known virologists, as well as the efforts of some of the less known, their lives and achievements are described. Included among others are John Buist, Martinus Beijerinck, Wendell Stanley, Robley Williams, George Sternberg, Gilbert Dallforth, Alice Woodruff, Ernest Goodpasture, John Enders, and Jonas Salk. The last part of the book deals with the newest knowledge about cells, genes, and viruses as a possible cause of cancer. (a.av., adv., sp.r., HR)

MEDICINE TODAY: A REPORT ON A DECADE OF PROGRESS, by Marguerite Clark. *Punk & Wagnalls*. 1960. 360 pages. \$4.95.

A very informative survey of the dramatic progress made in medicine in recent

years. Tells about new techniques in cancer and heart surgery, in the treatment of virus diseases, diabetes, muscular dystrophy, multiple sclerosis, cerebral palsy, allergies, rheumatism, arthritis and in many other areas of medicine. Although medicine has accomplished very much, it still has many problems to solve and diseases to conquer. (g.av.r., R)

THE COURAGE OF DR. LISTER. See BIOGRAPHY.

SHOTS WITHOUT GUNS, by Sarah R. Riedman. *Rand McNally*. 1960. 232 pages. Illustrated. \$3.50.

The story of vaccination presented through the lives and achievements of Jenner, Pasteur, Koch, Von Behring, Schick, the Dicks, Ehrlich, Salk, and others who did the research, made the inroads and led to the conquest of infectious diseases. (g.av.r., sp.r., HR)

LOUIS PASTEUR. See BIOGRAPHY.

THE DEDICATED, by Willa Gibbs. *Morrow*. 1960. 224 pages. \$3.50.

An engrossing novel based on the hard-fought medical battle in connection with vaccination against smallpox between Dr. Edward Jenner and Dr. William Woodville who represented the doubting medical profession.

THE HEALTH HUCKSTERS, by Ralph Lee Smith. *Crowell*. 1960. 248 pages. \$3.95.

An expose of the false and misleading advertising in vitamins and minerals, dentrifices and cold remedies, diet formulas, heart remedies, ethical drugs, cigarette claims, cosmetics, etc. which persuade the American public to spend more than a billion dollars a year on products which are of no real benefit. The author suggests a program to protect the American consumer against falsification of medical truth for commercial profit. (g.av.r., sp.r. HR)

Nature & Natural History

THE EDGE OF THE SEA, by Rachel Carson. *New American Library*. 1959. 240 pages. Illustrated. Paperbound. 50¢.

A reprint of one of the finest books on the natural history of the water's edge off the Atlantic coast of North America.

EXOTIC BIOLOGY, by Willy Ley. *Viking*. 1959. Illustrated by Olga Ley. \$5.95.

This volume summarizes and brings up to date most of the material which Dr. Ley has written previously on bizarre, rare, and extinct animals, some scientific mysteries in the world of flora and fauna. He describes a multitude of creatures, real and mythical, identified and baffling, from the far corners of the earth and the ranges of geologic time, such as the unicorn, the abominable snowman, the dragon from Lias Epsilon, mammoths, Kraken, sea-serpents, man-eating trees, the dodo and the tortoises, the platypus, the aardvark, etc. (a.av., m., R)

THIS IS NATURE. Selected and edited by Richard Westwood. *Crowell*. 1959. 214 pages. Illustrated. \$5.95.

Forty-five stories from *Nature* magazine, selected by the editor as the best and most worthy of republication, some written by such famous nature writers as E. Laurence Palmer, William Beebe, Edwin Way Teale, Donald Curloss Peattie, and Alan Devoe. Contains much human interest and some excellent photographs. (g.av.r., sp.r.)

NO ROOM IN THE ARK, by Alan Moorehead. *Harper*. 1959. 228 pages. Illustrated. \$5.00.

An interesting and well-written account of some of the natural spectacles exhibited in the world of animals, birds and reptiles in Africa. Some of the excitement and mystery of Africa's wild animals and primitive tribes are transmitted in this narrative which is based on the author's travels and experiences in Africa during the past few years. (a.av.r., R)

OUT OF NOAH'S ARK, The Story of Man's Discovery of the Animal Kingdom, by Herbert Wendt. *Houghton Mifflin*, 1959. 464 pages. Translated from the German by Michael Bullock. Illustrated. \$6.50.

Man's efforts to discover and describe his animal companions on earth ranging from pre-historic times to the present are presented in a scholarly and very lucid exposition by the author of *In Search of Adam*. The story begins with Cro-Magnon painting animals in the caves of southern France, continues with the search for and pursuit of animals by Greeks, Romans and in the Middle Ages, and is brought up-to-date with the work of modern scientific zoology. (adv., s.ab., m., HR)

UNDER THE SEA, by Maurice Burton. *Watts*. 1960. 256 pages. Illustrated by M. Wilson. \$4.95.

Introduces the reader to the past history of the sea, then takes him on a journey to the shore, the shallow sea and to the deep ocean to study plant and animal life from single-celled structures to animals with backbones and great fish and monsters. Discusses the methods and instruments of exploration used by oceanographers and marine biologists. (g.av., a.av.r., R)

THE WONDERS I SEE, by John K. Terres. *Lippincott*. 1960. 256 pages. Illustrated by W. Ferguson. \$5.00.

The author, editor of *Audubon Magazine*, and writer on wildlife, presents intimate and informative sketches on the habits of birds, animals and insects and the ways in which he ferreted out their secrets. The selections are taken from his naturalist's journal and the observations cover the span of one year. (g.av.r.)

SCIENCE ON SHORES AND BANKS, by Elizabeth K. Cooper. *Harcourt, Brace*. 1960. 188 pages. Illustrated. \$3.25.

Tells how to explore plant and animal life which abounds in, on and near any body of water. Gives instructions on finding and collecting living forms, what to do with the collections, what kind of experiments to perform, and how one can better understand and enjoy his environment. (g.av.r., R)

Plants

PLANT LIFE, by Lorus J. and Margery Milne. *Prentice-Hall*. 1959. 358 pages. Illustrated. \$6.95.

Introductory background to the plant kingdom: the principles of living things, the plant phyla, the fossil record and the evolution of plants, their economic value, life zones and biotic potential, adaptations, and the relation of plants to the future of human welfare. (a.av., adv., Rf, R)

THE PLANT KINGDOM, by Harold C. Bold. *Prentice-Hall*. 1960. 114 pages. Illustrated. Paperbound. \$1.50.

Takes up the four major phyla of the plant kingdom. Examines the diversity of plants and emphasizes their biological similarities and interrelationships, their basic structure and reproduction. (a.av., adv. RF, R)

CHEMISTRY

CHEMISTRY: THE ELEMENTS AND THEIR REACTIONS, by Eric Hutchinson. *Saunders*. 1959. 746 pages. Illustrated. \$7.50.

The idea of the structure of the atom is developed early in the text and the chemical properties of the elements are then deduced as a consequence of atomic structure. This is followed by a discussion of the physical laws and principles and their application to chemical systems, the fundamental chemical reactions, and a description of the representative elements of the various chemical families with emphasis on their economic importance. (s.ab., m, Rf, R)

ELEMENTS OF THE UNIVERSE, by Glenn T. Seaborg and Evans G. Valens. *Dutton*. 1958. 254 pages. Illustrated. \$3.95.

Using the Periodic Table as the unifying theme, the authors (Dr. Seaborg is a Nobel Prize winner in chemistry) present the science of chemistry in a rather unique and novel way, from alchemy to the synthesis of element #101. The research that led to the discovery of the transuranium elements is described by some of the scientists themselves. Fine photos and drawings highlight the stimulating narrative. (s.a., g.av.r, HR)

MODERN CHEMISTRY, by John F. Baxter and Luke E. Steiner. Vol. I. *Prentice-Hall*. 1959. 278 pages. Illustrated. Paperbound. \$2.50.

The text follows the order of lecture topics presented on TV's Continental Classroom first-semester course in modern chemistry. Stresses fundamental principles and concepts and the theories and ideas in the light of present-day research and knowledge. (a.av., s.ab., Rf, HR)

URANIUM AND OTHER MIRACLE METALS, by Fred Reinfeld. *Sterling*. 1959. 130 pages. Illustrated. \$3.95.

A revised and up-to-date edition of the book which was originally published in 1955. Tells the story of uranium and other atomic energy producing elements: where they are found and mined, how atomic energy is released by fission, how atomic power is used today and what it may accomplish in the future. Also discusses radioactivity, radioisotopes and their uses, nuclear reactors, and the metallurgy and uses of the metals Li, Be, Ti, Cs, Co, V, Mo, Th, Ge, Mg, and others (g.av., a.av.r, R)

DISCOVERING CHEMISTRY, by Elizabeth K. Cooper. *Harcourt, Brace*. 1959. 190 pages. Illustrated. \$3.50.

About 100 safe experiments are described, requiring mostly inexpensive materials and equipment generally found at home or available commercially. Each experiment illustrates a principle, or a law, or shows the relationship of chemistry to everyday things. Preceding the experiments is an introduction to the fundamentals and language of chemistry and instructions on how to set up a home laboratory. (s.a., g.av.r., R)

THE ROMANCE OF CHEMISTRY: From Ancient Alchemy to Nuclear Fission, by Keith Gordon Irwin. *Viking*. 1959. Illustrated by A. Ravioli. 148 pages. \$3.75.

An exceedingly well-written history of chemistry from the days of early chemical arts to present-day knowledge of atomic structure and the discovery of the transuranium elements. The story is told in terms of the achievements and contributions of chemistry's great: Boyle, Priestely, Lavoisier, Dalton, Cavendish, Gay-Lussac, Avogadro, Berzelius, Davy, Mendelyev, Ramsay, Kekule, Moseley, Curie, Hall, Frisch, Haber, Langmuir, and others (s.a., g.av.r., HR)

ATOMS, MOLECULES AND CHEMICAL CHANGE, by Ernest Grunwald and Russell H. Johnson. *Prentice-Hall*. 1960. 254 pages. Illustrated. \$6.00.

This text in freshman chemistry for non-science majors emphasizes the structure of matter and the chemical consequences of that structure. Uses the historical as well as logical sequence in developing fundamental principles and concepts. The principles of ionic and covalent compound formation, the architecture and reactions of covalent molecules, the atomic nucleus and nuclear reactions are stressed and discussed with unusual clarity. (adv., sp.r., Rf, HR)

EARTH SCIENCE

1001 QUESTIONS ANSWERED ABOUT THE MINERAL KINGDOM, by Richard M. Pearl. *Dodd, Mead*. 1959. 236 pages. Illustrated. \$6.00.

Accurate and up-to-date information on minerals and crystals in the form of questions and answers. Among the topics covered are igneous, sedimentary and

metamorphic rocks; base, rare and radioactive metals; gems, industrial minerals and rocks; fossil fuels; mining and milling; water resources; and mineralogy as a hobby. (s.a., g.av.r., Rf, R)

THE DOUBLE PLANET, by Isaac Asimov. *Abelard-Schuman*. 1960. Illustrated by J. Bradford. 160 pages. \$3.00.

The story of how men through the ages have probed the secrets of the earth and its cyclic relationship with its satellite, the moon. Both history and new information brought out by modern space exploration are included in this graphic and interesting account. (g.av.r., HR)

OUR EARTH, by Arthur Beiser. *Dutton*. 1959. 124 pages. Illustrated. \$3.25.

Dr. Beiser discusses the generally accepted facts and theories concerning the planet earth and includes some of the information obtained by I. G. Y. scientists. Some of the topics discussed are the size of the earth, its position in the solar system, the structure and composition of the earth's interior and crust, time and tides, terrestrial magnetism, and recent theories concerning the origin and age of the solar system. (a.av.r, adv., sp.r., R)

EXPLORING CAVES, by Polly Longworth. *Crowell*. 1959. 176 pages. Illustrated by G. Schrotter. \$2.75.

An excellent, simple introduction to speleology. Tells how caves are formed, what they look like, how they are discovered, what animals live in them, and how to protect them. Also instructions on how to become an amateur speleologist: how to look for caves, what to wear when one goes caving, what kind of equipment to take along, and the rules one must follow in spelunking. (g.av.r., R)

I G Y: YEAR OF DISCOVERY, by Sidney Chapman. *University of Michigan Press*. 1959. 112 pages. Illustrated. \$4.95.

Gives an account of some of the scientific aspects of the earth and the sun in special connection with the International Geophysical Year (1957-'58). Describes what has been learned so far during that period about earthquakes, glaciers, oceans, the upper atmosphere, ionosphere, the aurora, earth's magnetism, cosmic rays, the sun, and nuclear reactions. This book was awarded the 1960 Thomas Alva Edison Foundation Award for the "year's best science book for youth." (g.av., a.av.r., HR)

PLANET EARTH, by Karl Stumpff. *University of Michigan Press*. 1959. 192 pages. Illustrated. Paperbound. \$1.95.

Tells what science has learned about the earth: its origin, movements, structure, size, shape, terrestrial magnetism, the atmosphere, the earth's relation to the sun and its place in the solar system. (s.ab., m. Rf. HR)

BIOGRAPHY OF THE EARTH. See ASTRONOMY & COSMOLOGY.

THE STORY OF EARTH SCIENCE, by Horace R. Richards. *Lippincott*. 1959. 192 pages. Illustrated. \$3.75.

Describes the major divisions of the earth and its geologic history; invertebrate, vertebrate and plant fossils; igneous, sedimentary and metamorphic rocks; and minerals. Explains what they are and how they are formed and describes examples of each. (s.a., g.av.r., R)

TIME, LIFE AND MAN: The Fossil Record, by Ruben Arthur Stirton. *Wiley*. 1959. Illustrated. \$9.00.

A general introductory text to the study of prehistoric life as evidenced in fossils preserved in the earth's crust. Outlines the objectives and general principles, traces the history of the science, and gives a simple classification of living and extinct plants and animals. Presents chronologically the sequence of life from the pre-Cambrian to the Pleistocene periods, with emphasis on the fossil record. (s.ab., m. Rf)

WINDOW IN THE SKY, by Homer E. Newell. *Whittlesey House*. 1959. Illustrated by G. Schrotter. 120 pages. \$2.75.

Describes the upper atmosphere, its composition and behavior, and the many interesting phenomena which occur at high altitudes. (g.av.r., R)

THE EARTH: ROCKS, MINERALS AND FOSSILS, by W. B. Haland. *Watts*. 1960. 256 pages. Illustrated by P. Chadwick. \$4.95.

An excellent introduction to the science of the earth. Tells what geology is all about and some of the outstanding problems facing the geologist. Presents the earth as it is now, its inner and outer structure and the forces which are at work in it and on it. Discusses the earth's history, the story of life on it, and the earth's resources. Encourages the reader to explore, collect and study rocks, minerals and fossils. (g.av.r., HR)

OUR ATMOSPHERE, by Theo Loesback. *New American Library*. 1960. 192 pages. Illustrated. Paperbound. 50¢.

An account of the earth's atmosphere, its history, layers, the various phenomena associated with it (weather, tornadoes, hurricanes, thunder and lightning, air cycles, etc.), and man's efforts to control and improve weather. (a.av. r.)

EXPLORING THE RIVER, by John and Jane Greverus Perry. *Whittlesey House*. 1960. 204 pages. Illustrated. \$3.50.

A journey along a river, 450 miles long, from its source to the sea, surveying and exploring on the way its entire path, its plant and animal life, its geography and ecology, and the river's effects on the people, their industry, commerce, agriculture, and life. (g.av.r., R)

MATHEMATICS

CLASSICAL MATHEMATICS, by Joseph E. Hofmann. *Philosophical Library*. 1959. Translated from the German by H. O. Midonick. 158 pages. \$4.75.

The history of mathematics during the 17th and 18th century, periods known as the High and Late Baroque and the Age of Enlightenment. Describes the advances and achievements made in many areas, such as the system of Descartes, the discovery of the power series, the invention of the calculus and the controversies over it, and the contributions of Euler, Lambert, Lagrange, Laplace, Legendre, and other mathematicians to what is known as the classical era in mathematics. (a.av., Rf)

THE GENTLE ART OF MATHEMATICS, by Dan Pedoe. *Macmillan*. 1959. 144 pages. Illustrated. \$3.50.

The book describes, in highly readable and understandable language, some of the highlights of modern mathematics: probability, symbolic logic, topology, aesthetics, rational and irrational numbers, symmetry and series, the problem of infinity, and some mathematical games and puzzles. There are a number of practical problems and applications of modern mathematics. Instructive and enjoyable reading. (a.av., HR)

INTRODUCTION TO HIGHER MATHEMATICS, by Constance Reid. *Crowell*. 1959. 184 pages. \$3.00.

Discusses some of the most fundamental and challenging ideas of modern mathematics with great clarity and by the use of ample illustrative material. The topics include the number theory, symbolic algebra, the theory of groups, infinity, non-Euclidean geometry, analytic and projective geometry, topology, integral and differential calculus, point set theory, sentential calculus, and methods of mathematical proof. (s.ab.-i, m. HR)

MATHEMATICS AND THE PHYSICAL WORLD, by Morris Kline. *Crowell*. 1959. 482 pages. \$6.00.

How scientists have used and are using mathematics in exploring of and explaining the basic principles of the physical world and in organizing this knowledge into scientific theories is the main theme of this readable and highly provocative book. By means of numerous examples the author brings out the role of mathematics in the scientific study of nature and the interplay and interrelationship of mathematics and science. (s.ab. +i, R)

REALM OF NUMBERS, by Isaac Asimov. *Houghton Mifflin*. 1959. 200 pages. Illustrated. \$2.75.

Presents mathematical concepts and ideas, from the meaning and use of numbers (digits, zero, fractions, the decimal system, powers, roots) to the concept of infinity and the theory of "transfinite numbers," with simplicity and clarity. (g.av.r., R)

FROM ZERO TO INFINITY, by Constance Reid. *Crowell*. 1960. 161 pages. \$3.95.

"What makes numbers interesting" is the subtitle of this book, and this book is certainly one of the most interesting books about a fascinating subject, the natural number. Each digit has a story of its own, and a chapter is devoted to the history, lore and mathematical ideas connected with each number, from zero to nine. There are problems, quizzes and challenges at the end of each chapter. This revised edition also has a new up-to-date chapter on infinite sets. (a.av., HR)

THE NEW MATHEMATICS, by Irving Adler. *New American Library*. 1960. 192 pages. Illustrated. Paperbound. 50¢.

Explains in clear language the working methods, ideas and fundamental concepts of modern mathematics. Contains do-it-yourself sections at the end of each chapter and in the supplement. (HR)

PHYSICAL SCIENCE

ATOMS TODAY AND TOMORROW, by Margaret O. Hyde. *Whittlesey House*. 1959. 160 pages. Illustrated by C. N. Geary. \$3.00.

A revised edition which includes new material on atomic farming, the uses of atomic energy in industry, the control of radioactivity and the uses of radioisotopes, and the effects of bomb tests on weather. (g.av.r.)

1001 QUESTIONS ANSWERED ABOUT THE NEW SCIENCE, by David O. Woodbury. *Dodd, Mead*. 1959. 358 pages. Illustrated. \$6.00.

Up-to-date information, presented in question and answer form, on the following subjects: space and its conquest, atomic and nucleonics, engineering technology, automation, physics, electronics, chemistry, mineralogy, and mathematics. (g.av.r., a.av., sp.r., Rf)

THE KINGDOM OF THE SUN. See ASTRONOMY & COSMOLOGY.

BETWEEN EARTH AND SPACE, by Clyde Orr, Jr. *Macmillan*. 1959. 254 pages. Illustrated. \$4.95.

In an exploratory journey through the air above us, the reader is given an explanation on how the air has come into being, on the "structure" and behavior of the various atmospheric regions, the how and why of wind, storm, rain, hail, snow and lightning, and other associated phenomena and problems of weather and climate. (a.av., adv., sp.r.)

THE MOON. See ASTRONOMY & COSMOLOGY.

THE CLOCK WE LIVE ON, by Isaac Asimov. *Abelard-Schuman*. 1959. 176 pages. Illustrated. \$3.00.

The author tells the story of man's age-old struggle to find workable systems of dealing with the complexities of time. He describes the ways used to tell time outdoors and indoors and the various calendars which have been invented and used

in the course of centuries. He emphasizes that time still depends on the steady spin of the earth—"the clock we live on." (g.av.r., R)

FUN WITH THE SUN, by D. S. Halacy, Sr. *Macmillan*. 1959. 112 pages. Illustrated. \$2.75.

Seven author-tested solar projects are described and instructions and diagrams for their construction and use are given. Discusses solar energy, how it is now being harnessed and how it may be utilized in the future as a fuel for the millions in underprivileged areas. (g.av.r., R)

A BOY AND A BATTERY, by Raymond F. Yates. *Harper*. 1959. 120 pages. Illustrated. \$2.50.

A fully revised edition of a book originally published in 1942 which takes up the various aspects of electricity, electromagnetism, thermoelectricity, the solar cell, and the atomic battery, and provides many instructive experiments in these areas. (s.a., g.av.r.)

THE BOYS' BOOK OF MAGNETISM, by Raymond F. Yates. *Harper*. 1959. 162 pages. Illustrated. \$2.75.

Discusses the theory and applications of magnetism and electromagnetism and includes many instructive and easy-to-perform experiments. This is a revised edition of a previously published book, now brought up to date. (s.a., g.av.r.)

EXPERIMENTAL ELECTRICITY FOR BOYS, by Willard Doan. *Rider*. 1959. 128 pages. Illustrated. \$3.45.

Experiments and construction projects to teach the fundamentals of magnetism, static electricity, cells and batteries, current electricity, properties and uses of conductors and insulators, effects of the electric current, electromagnetic inductance, transformers, Tesla coils, dynamos and motors, bells and buzzers, the telegraph and telephone. The projects range from easy to difficult ones and call for manual dexterity and understanding of principles. (s.a., g.av.r., sp., R)

EXPLORING SCIENCE, by Jonathan N. Leonard. *World*. 1959. 320 pages. Illustrated by L. Darling and I. N. Steinberg. \$4.95.

An extremely well-written introduction to the physical world by the science editor of *Time*. The first part of the book, "The World Around Us," describes the universe. The second part, "Man in the World," shows how the human race is learning about, and sometimes manages to control, the forces of nature in the nearest part of his universe. It describes man's tools, his mass production methods, his means of communication and transportation, the energy he uses, and the unlimited opportunities that face him. (g.av.r., sp.r., HR)

THE ROMANCE OF WEIGHTS AND MEASURES, by Keith Gordon Irwin. *Viking*. 1960. 144 pages. Illustrated by J. Troyer. \$3.50.

The story of how English weights and measures came to be, told against the background of history, from the earliest Anglo-Saxon times through the changes which were made in the 19th century and the trends in measurement practices in the 20th century. (g.av.r., sp.r., R)

ENGINES AND HOW THEY WORK, by Geoffrey Boumphrey. *Watts*. 1960. 256 pages. Illustrated by J. G. Blowne. \$4.95.

Describes the history and development of the engine, from the earliest pumps driven by wind and water to the many and complex machines of modern times, including the jet engine, the gas turbine and the rocket engine. Also discusses the utilization of energy from nuclear fission. (g.av.r., sp.r., HR)

REALM OF MEASURE, by Isaac Asimov. *Houghton Mifflin*. 1960. 192 pages. Illustrated by R. Belmore. \$2.75.

Explains the underlying theories of measure and describes the history of man's

gradual refinement of the tools and techniques involved. Begins with the development of the English system and ends with modern gravitational units and quanta. (g.av.r., sp.r. HR)

EDISON EXPERIMENTS YOU CAN DO. Text by Marjorie Van der Water. *Harper*. 1960. 130 pages. Illustrated. \$2.50.

Ten experiments based on the original notebooks of Thomas Edison: the telegraph, the electric light, the fuse, the Edison effect, the phonograph, and others. A brief biographical sketch prefaces the experiments. (g.av.r., R)

PHYSICS

THE A B C OF RELATIVITY, by Bertrand Russell. *New American Library*. 144 pages. Paperbound. 50¢.

A lucid explanation of the general and special theories of relativity and the far-reaching effects of Einstein's work upon science and the future of the modern world. (s.ab.+i., m.)

ATOMIC-AGE PHYSICS, by Henry Semat and Harvey E. White. *Rinehart*. 1959. 230 pages. Illustrated. Paperbound. \$2.00.

The subject matter of this book is based on the second half of the physics course presented on the TV Continental Classroom which dealt primarily with modern physics. (s.ab., m., Rf, HR)

ELECTROSTATICS. Edited by Alexander Schure. *Rider*. 1959. 64 pages. Illustrated. Paperbound. \$1.35.

Covers, both qualitatively and quantitatively, the fundamentals of the subject: the characteristics and behavior of electric charges, unit systems, the electric field, capacitance and capacitors, the electrostatics devices and applications. Review questions and problems at the end of each chapter. (Rf)

DIRECT CURRENT ELECTRICITY, by Alexander Efron. *Rider*. 1960. 92 pages. Illustrated. Paperbound. \$2.25.

Deals with the principles and applications of electrochemistry, series and parallel circuits, electrical measuring instruments, electricity and heat, and induced EMF. The author uses the Franklinian approach; that is, the direction of the current is taken to be from + to -. There are practical experiments and solutions to model problems in every chapter. The volume is No. 9 in the *Basic Science Series*. (Rf)

EFFECTS OF NUCLEAR RADIATION ON MEN AND MATERIALS, by T. C. Helvey. *Rider*. 56 pages. Illustrated. Paperbound. \$1.80.

An introduction to the basic concepts and definitions of nuclear physics and a summary of what is presently known about the physiochemical and biophysical effects of nuclear radiation and how to shield men and materials from harmful exposure. (Rf)

ELEMENTS OF RADIO, by Abraham Marcus and William Marcus. *Prentice-Hall*. 1959. Illustrated. \$5.25.

One of the finest and most teachable books in the field. Its organization, the presentation of the material, the content, the illustrations, the numerous teaching devices, and the demonstration section—all add up to make this fourth edition an excellent introduction to the principles and practice of radio. Since radio is barely touched upon in the high school physics course, this book will be valuable for those who want to know about the subject and will be stimulated to study it on their own. (Rf, HR)

RADIOACTIVE ISOTOPES IN CLINICAL PRACTICE, by Edith H. Quimby, Sergei Feitelberg and Solomon Silver. *Lea & Febiger*. 1958. 452 pages. Illustrated. \$10.00.

With the increased attention given to radioactivity in biology, chemistry and physics courses, there is a need for a definitive text and reference for both the teacher and student. This textbook fills the need. It is divided into three parts, each written by an authority who had the most to do with that field in teaching the course at Columbia University: Basic Physics (atomic structure, radioactivity, nuclear reactions and fission, interaction of radiation and matter, dosage calculations for radioactive isotopes, biological effects of ionizing radiations, radiation hazards, disposal of radioactive waste), Instrumentation and Laboratory Methods (radiation detectors, quantitative measurements in vitro and in vivo, autoradiography, use of radiation detectors in health protection), and Clinical Application of radioactive isotopes in diagnosis and therapy. (s.ab., adv. Rf, HR)

THE THIRTEEN STEPS TO THE ATOM, by Charles Noel Martin. *Watts*. 1959. 256 pages. Translated by B. B. Rafter. Illustrated. \$4.95.

In 118 black and white photographs and with suitable explanatory text, the author presents objects of increasing minuteness—from snowflakes, measuring in tenths of a centimeter (magnification 20 to 200), to electrons, measuring less than a ten-million-millionth of a centimeter (photos of iron and sulfur, magnification up to 20,000,000). Between these ranges are photos of protozoa, cells, diatoms, blood corpuscles, crystals, bacteria, viruses, molecules, atoms, and products of atomic disintegration. An informative and highly interesting guide to the study of the microcosm. (g.av., a.av., HR)

MAN-MADE SUN. See ATOMICS & NUCLEONICS

FUNDAMENTALS OF NUCLEAR ENERGY AND POWER REACTORS. See ATOMICS & NUCLEONICS.

EDISON. See BIOGRAPHY.

VACUUM TUBE CHARACTERISTICS, Edited by Alexander Schure. *Rider*. 1958. 96 pages. Illustrated. Paperbound. \$1.80.

Elementary introduction to electron emission and the characteristics and ratings of diodes, triodes, multigrid and special-purpose vacuum tubes. Theory is emphasized along with practical situations. Practice in applying principles is offered through drills in specific problems. (Rf)

ELECTRICAL GENIUS: Nicola Tesla. See BIOGRAPHY.

SCIENCE STUDY SERIES. *Doubleday*. Available through *Wesleyan University Press*. Paperbound. 95¢ each. Illustrated.

Seventeen titles have been published so far during 1959 and 1960 in this series under the direction and supervision of the *Physical Science Study Committee* (PSSC). Designed as supplemental reading for high school physics students (as well as for teachers and laymen) of inquiring minds, these books "bridge the gap between the textbook facts and principles and the fascinating details of scientific methods and discoveries." Each book provides an authoritative survey of a special topic and will give a better understanding of basic concepts and ideas in the physical world. They should be found in every departmental science library and science students should be encouraged to purchase them for their own library.

THE NEUTRON STORY, by Donald J. Hughes. 158 pages.

MAGNETS: The Education of Physicist, by Frances Bitter. 156 pages.

SOAP BUBBLES AND THE FORCES WHICH MOULD THEM, by C. V. Boys. 156 pages.

ECHOES OF BATS AND MEN, by Donald R. Griffin. 156 pages.

- HOW OLD IS THE EARTH? by Patrick M. Hurley. 160 pages.
- CRYSTALS AND CRYSTAL GROWING, by Alan Holden. 320 pages. \$1.45.
- THE PHYSICS OF TELEVISION, by Donald G. Fink. 160 pages.
- WAVES AND THE EAR, by Willem van Bergeijk, John R. Pierce and Edward E. David, Jr. 235 pages.
- THE BIRTH OF A NEW PHYSICS, by I. Bernard Cohen. 200 pages.
- STRINGS, HORNS, AND HARMONY, by Arthur H. Benade. 271 pages.
- THE RESTLESS ATOM, by Alfred Romer. 198 pages.
- MICHELSON AND THE SPEED OF LIGHT, by Bernard Jaffe. 156 pages.
- THE UNIVERSE AT LARGE, by Herman Bondi. 200 pages.
- PASTEUR AND MODERN SCIENCE, by René Dubos. 200 pages.
- THE WATERSHED: A Biography of Johannes Kepler, by Arthur Koestler. 280 pages.
- ACCELERATORS: Machines of Nuclear Physics, by Robert R. Wilson and Ralph Littauer. 200 pages.
- PHYSICS FOR EVERYBODY, by Germaine and Arthur Beiser. *Dutton*. 1960. 190 pages. Illustrated Paperbound. \$1.15.
- A non-technical introduction to the basic principles and ideas of mechanics, sound, heat, electricity and magnetism, electronics, and nuclear physics. (g.av.r.)
- ELECTRICITY: HOW IT WORKS, by Percy Dunsheath. *Crowell*. 1960. 250 pages. Illustrated. \$3.95.
- A clear and lucid discussion of the general areas of electricity: static electricity, magnetism, the electric current and its path, electromagnetic effects, mechanical generation of electricity, light and heat, the electric supply system, telecommunications, and electronics. The discussion is interspersed with historical incidents and with instructions for performing practical experiments. (g.av.r, sp.r., R)
- THE WORLD OF PHYSICS. Edited by Arthur Beiser. *McGraw-Hill*. 1960. 286 pages. \$4.25.
- Fifteen well-selected readings from the writings of some of the world's best known physicists and writers on science, each prefaced by a thoughtful brief analysis. Galileo's work on falling bodies and Lord Russell's on the significance of science in human affairs is followed by a survey of the leading developments of 20th-century physics and the exciting new developments of the last two decades: quantum physics, elementary particles, cosmic radiation, fusion power and space exploration. (s.ab., m., sp.r., Rf., HR)
- PHYSICS, FOUNDATIONS AND FRONTIERS, by George Gamow and John M. Cleveland. *Prentice-Hall*. 1960. 552 pp. Illustrated. \$7.95.
- Treats both classical and modern physics at the introductory level. The chapters on electronics, the wave nature of light, the special and general theories of relativity, the electrical nature of matter, the energy quantum, wave nature of particles, the atomic nucleus, nuclear transformations and reactions, and elementary particles are given understandable treatment. Special chapters are devoted to the newer fields of biophysics, geophysics and astrophysics. (s.ab., adv., Rf, HR)
- SCIENTIFIC CAREERS**
- CAREERS AND OPPORTUNITIES IN CHEMISTRY, by Philip Pollack. *Dutton*. 1960. 146 pages. \$3.50.

A realistic account of the opportunities and rewards in the chemical profession. After discussing the qualifications and training required, the author analyzes in clear and non-technical language each of the following areas of the chemical profession: organic, inorganic, analytical, biochemical, physical, chemical engineering, technical selling and commercial chemical development. (g.av., a.av., s.ab.+l., Rf, HR)

THERE'S ADVENTURE IN GEOLOGY

THERE'S ADVENTURE IN MARINE SCIENCE, by Julian May. *Popular Mechanics*. 1959. 165 pages each. Illustrated. \$2.95 each.

Two more volumes in an easy-to-read and very interesting series which by means of a narrative about a youth and his science-oriented father lead the readers into investigating careers in the fields of geology and oceanography. (s.a., g.av.r., R)

DISEASE DETECTIVES: Your Career in Medical Research, by Harry Edward Neal. *Messner*. 1959. 192 pages. \$3.50.

Describes what goes on behind the scenes in medical-research laboratories in the career opportunities which exist in the various life sciences (biology, bacteriology, physiology, biochemistry, biophysics, radiology, pharmacology), in medical art and photography, medical record library science, sanitary engineering, and other professions associated with medical research. (g.av., a.av.r., R)

CAREERS AND OPPORTUNITIES IN SCIENCE, Philip Pollack, *Dutton*. 1960. 194 pages. Illustrated \$3.95.

A survey of a number of scientific fields which offer rewarding careers and opportunities for the capable and science-oriented students. Discusses the necessary personal and educational qualifications, the required training, the remuneration, advancements and rewards available in the following areas: physics, chemistry, atomic energy, geology, biology, medical research, and conservation. A special chapter is devoted to career opportunities for women. (g.a., a.av., s.ab.+l., Rf, HR)

SO YOU WANT TO BE A SCIENTIST, by Alan E. Nourse. *Harper*. 1960. 182 pages. \$3.00.

First explores the life of a scientist and the kind of work he does. Outlines the qualifications, goals and training required of a scientist and describes the broad fields of science as a guidepost for the choice of a scientific career. (g.a., a.av.r., R)

ENGINEERS UNLIMITED, by Harry Edward Neal. *Messner*. 1960. 192 pages. Illustrated. \$3.50.

Discusses the opportunities and careers available to young men and women in the various areas of engineering: civil, sanitary, hydraulic, aeronautical, mechanical, electrical and electronic, mining and metallurgical, chemical, agricultural, and others. Gives information on qualifications, training and remuneration (g.av.r., s.i., R)

SCIENTIFIC RESEARCH

SCIENCE IN PROGRESS. Eleventh Series. Edited by Hugh Taylor. *Yale University Press*. 1960. 380 pages. Illustrated. \$7.50.

The newest volume in the outstanding series of biennial reports by eminent scientists on the latest developments in their fields. The first six essays are devoted to research resulting from I.G.Y. activities. The other contributions are: "The Biological Control of Chemical Factors in the Environment," by A. C. Redfield; "The Experimental Analysis of Behavior," by B. F. Skinner; "Chemical Anthropology," by Roger J. Williams; "Smoking and Death Rates—A Riddle in Cause and Effect," by E. C. Hammond; "Viruses as the Causes of Cancer," by J. W. Beard; and "The World of Fine Particles," by J. Turkevich. (adv., s.ab., m.)

SATURDAY SCIENCE, by Andrew Bluemle. *Dutton*. 1960. 334 pages. Illustrated. \$5.95.

Insight into and understanding of what's going on in modern-day research in the behavior of our physical world are given in the series of lectures by scientists of Westinghouse Research laboratories collected in this book. The lectures deal with some theoretical and practical aspects of physics and chemistry, such as the crystal structure and the chemistry of solids, low temperature phenomena, the physics and microstructure of metals, surface films, the principles of space propulsion, and the mathematical and analytical tools and techniques used by scientists, (a.v., avd. sp.r., HR)

ROADS TO DISCOVERY, by Ralph E. Lapp. *Harper*. 1960. 190 pages. Illustrated. \$3.75.

The story of the scientific research that led to the release and utilization of atomic energy as seen in the work and contributions of Roentgen, Becquerel, the Curies, Rutherford, Bohr, Chadwick, Fermi, Bethe, and others. (g.v.r., HR)

GENERAL

THE ARMCHAIR SCIENCE READER. Edited by Isabel S. Gordon and Sophie Sorkin. *Simon & Schuster*. 1959. 832 pages. \$7.95.

An anthology of scientific works, short stories, poetry, biography, articles, etc. selected from the writings of great scientists (Galileo, Newton, Darwin, Mueller, Einstein, Langmuir, Eddington, Thomson, Huxley, Oppenheimer), writers on scientific subjects (Verne, Krutch, Kaempffert, De Kruif, Eve Curie, de Harshanyi), and of literary greats (Wadsworth, Keats, Shelley, Whitman, Nash, Sandburg, and others). Enjoyable and informative reading for leisure time. (R)

SPECTRUM: THE WORLD OF SCIENCE. Edited by Ray Ginger. *Holt*. 1959. 116 pages. Illustrated. \$3.95.

Articles and excerpts from books which present many of the basic ideas and results of recent research in the areas of chemistry, evolution, cytology, space science, physics, probability, and psychology. The topics include, among others, man-made radioactive elements, a case study of evolution in terms of amphibians, what we know about the structure and chemistry of the cell, how life originated and the probability of life on other worlds, the building of the Brooklyn Bridge, and the theory and application of probability. There are also photographic essays on order in nature, the production and decay of strange particles, polioviruses, and radio-astronomy. (HR)

WORDS OF SCIENCE AND THE HISTORY BEHIND THEM, by Isaac Asimov. *Houghton Mifflin*. 1959. 268 pages. Illustrated by W. Barss. \$5.00.

Two hundred-fifty words used in various areas of science and mathematics, from absolute zero and acid to x-rays, yttrium and zero, defined and described in clear and understandable language. One page is devoted to each term, giving its origin, history, the scientists who played a part in its story, and its present-day usage. Excellent guide to scientific vocabulary; may be used with profit to supplement glossaries and dictionaries. (HR)

WONDERS OF THE WORLD, by Leonard Cottrell. *Rinehart*. 1959. 250 pages. Illustrated. \$4.50.

An account of the achievements of past civilizations and the marvelous technical engineering feats of modern times. Contrasted with the seven wonders of the ancient world (the Lighthouse of Alexandria, the Hanging Gardens of Babylon, the Colossus of Rhodes, etc.) are the present-day products of man's ingenuity and technical skill such as the Empire State Building, the Golden Gate Bridge, the first-large-scale electrical engineering station powered by atomic energy at Calder Hall, the Grand Coulee Dam, the largest radio-telescope in the world, Sputnik I, and others. (g.v.r., m., s.i.)

THE CANAL BUILDERS: The Story of Canal Engineering Through the Ages, by Robert Payne. *Macmillan*. 1959. 278 pages. Illustrated. \$5.00.

The history of canals and canal-building over the centuries and all over the world. Among the engineering marvels described in this book are the labyrinth of Egypt, the ancient waterways built by the Babylonians, Greeks, Romans and Arabs, the man-made rivers of the Italian Renaissance, the canals of England and America, the Panama and Suez canals, and the work-in-progress on some of the projects of modern-day canal building. (g.av.r., m. s.i.)

SCIENCE SCIENCE SCIENCE: Experiment and Discovery Along Man's Road to Knowledge of Himself and His World. Selected by Russell Hamilton. *Watts*. 1960. 210 pages. \$2.95.

Twenty-two selections from some of the best in science writing dealing with the discoveries and contributions of such scientists as Galileo, Leeuwenhoek, Cavendish, Newton, Herschel, Darwin, Baekeland, Langley, Thomson, Rutherford, and others. (g.av.r., sp.r., R)

WHAT'S NEW IN SCIENCE, by Fred Reinfeld. *Sterling*. 1960. 204 pages. Illustrated. \$3.95.

A survey of recent advances in the fields of electronics (computers, radar), surface travel, medicine and mental health, sound and light (ultrasonics, infrared radiation), space (radiation, satellites, radio astronomy), atomics (nuclear submarines and planes, thermoelectricity, controlled fusion), television, meteorology, and oceanography. (g.av.r., sp.r., R)

SCIENTISTS WHO CHANGED THE WORLD, by Lynn & Gray Poole. *Dodd, Mead*. 1960. 164 pages. Illustrated. \$4.00.

The story of the contributions of seventeen scientists to the "structure of scientific and human development." Included are Hippocrates, Copernicus, Harvey, Newton, Lavoisier, Darwin, Lister, Pasteur, Madame Curie, Rutherford, Freud, Einstein, and others. (g.av.r., R)

THE LIVING HOUSE, by George Ordish. *Lippincott*. 1960. 320 pages. Illustrated. \$4.50.

A vividly-written narrative which traces the history of human, animal and insect life in a 400-year-old house typical of the English country-side and which describes the interaction of all living things and the relationship between them and the environment. Shows man as a part of nature who plays an important role in its balance. (a.av., s.i.)

CONCISE DICTIONARY OF SCIENCE, by Frank Gaynor. *Philosophical Library*. 1959. 546 pages. \$10.00.

Scientific terms, alphabetically arranged and concisely defined, in the fields of astronomy, chemistry, mathematics, nucleonics, and physics. (Rf)

COMMUNICATIONS: FROM STONE AGE TO SPACE AGE, by Harry Edward Neal. *Messner*. 1960. 192 pages. Illustrated. \$3.50.

The story of the evolution of speech, writing and other means of communications from man's first attempts at speech to present-day complex electronic devices used to communicate with and from space satellites. (g.av.r., R)

ARCHEOLOGISTS AND WHAT THEY DO, by Robert J. Braidwood. *Watts*. 1960. 180 pages. \$3.95.

GOOD DIGGING, by Dorothy and Joseph Samachson. *Rand McNally*. 1960. 224 pages. Illustrated. \$3.50.

The first book takes the average reader on an archeological "dig," explaining what an archeologist is, what he does, how he prepares for an expedition, the actual work at the site, and what he does with his find.

The second is more of a history of archaeology; it tells about the development of the science and about famous archaeological discoveries and their discoverers. It devotes the final chapters to the training of an archaeologist, amateur and professional. (g.av.r., HR)

SCIENCE FICTION

S F : 59. Edited by Judith Merrill. *Gnome*. 1959. 256 pages. \$3.50.

The fourth annual volume in a series of science-fiction anthologies. Stories of fantasy, the future, and the mysterious universe—some very exciting and fascinating. Each story is briefly prefaced by the editor. A non-fiction section on "man-in-space" is included; also a summary of the "year's best" in science-fiction writing.

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 University of Michigan Press, Ann Arbor, Michigan
 Franklin Watts, Inc. 575 Lexington Ave., New York 2, N. Y.
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 Whittlesey House. See McGraw-Hill
 John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.
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 Yale University Press. New Haven, Connecticut

Note on a Detail of the Proof that $\sqrt{2}$ Is Irrational

Walter H. Carnahan

1932 Adams Drive, Madison, Indiana

A well known proof that $\sqrt{2}$ is irrational begins with the assumption that $\sqrt{2} = a/b$ where a and b are integers that have no common factor. Squaring and multiplying give $a^2 = 2b^2$. That is, a^2 is an even number. Now, it is essential to show that a is an even number. Usually it is proved that a is not an odd number and the conclusion is drawn that it is therefore even. This proof is made by assuming that a is odd, say $a = 2n+1$. Then $a^2 = 4n^2 + 4n + 1$, and thus a^2 is odd. But we know that a^2 is even and we at once conclude that a cannot be odd.

I wish to outline a direct proof that a is even, thus avoiding any possible objection on the basis of the excluded middle of logic. Having derived the relation $a^2 = 2b^2$ in the usual manner, let $a = 2x + y$ where x is zero or an integer, y is an integer, no assumption being made as to whether y is even or odd. Then $a^2 = 4x^2 + 4xy + y^2 = 4x^2 + y(4x + y) = 2b^2$. Hence, $4x^2 + y(4x + y)$ is an even number for all x, y . Since $4x^2$ is even, then $y(4x + y)$ must be even. Hence, either y is even, or $4x + y$ is even, or both. Now, since $4x$ is even, $4x + y$ is even if y is even, and finally a is an even number.

The remainder of the proof that $\sqrt{2}$ is irrational is as usually given.

The above argument can be generalized as follows to show that any integral root of any prime is irrational. Let p be any prime and consider $p^{1/r}$. Suppose $p^{1/r} = a/b$ where a and b are relatively prime integers. Then $a^r = pb^r$. Now, a^r is an integral multiple of p . We wish to show that a is also an integral multiple of p , and hence that the assumption that a and b are relatively prime leads to a contradiction. Suppose $a = px + y$, no assumption being made regarding x and y except that they are integers; y may be zero. Then,

$$a^r = p^r x^r + r p^{r-1} x^{r-1} y + \dots + y(y^{r-2})(rpx + y)$$

Every term in the right member of this relation is an integral multiple of p except possibly $y(y^{r-2})(rpx + y)$. This term must be an integral multiple of p because a^r is. Now, this term can be an integral multiple of p only if y is such a multiple, or y^{r-2} is, or $(rpx + y)$ is, or two or all three factors are. Now, rpx is an integral multiple of p and hence $(rpx + y)$ is an integral multiple of p only if y is such a multiple. That is, if the first, second, and third factors of $y(y^{r-2})(rpx + y)$ are all integral multiples of p . Therefore, $p = a/b$ cannot be true for integral a and b with no common factor, and p is not rational.

Chemistry Research in the High School

Arthur Hirsch,¹

Rabbi Teits Mesifita Academy, Elizabeth, N. J.

Means for increasing the interest of high school students in the sciences are currently sought. Science projects,² advanced courses for the gifted,³ and other programs selected for the needs of the student with a special science aptitude, have been reported.

It was felt, however, that interest in science could and should be stimulated at an earlier stage in a student's education. Consequently, a program for high school freshmen and sophomores with little or no science training was developed and successfully instituted at R.T.M.A. This program followed the proven principle of Cartelyou,⁴ that research can be carried on by non-degree personnel. What remained to be tested was the theory that high school students with a limited science background could, working in small groups, with the proper guidance, tackle research projects. At R.T.M.A. we were fortunate to have a number of Scientists volunteer their services for this experimental program. Each accepted a small group of select students. In no case did a research team consist of more than six youngsters.

The objectives of this program briefly summarized were:

1. To stimulate interest in science through the presentation of problem(s) awaiting solution.
2. To inculcate the importance of the scientific method through an experimental approach to the search for a solution to the problem.
3. To impart new laboratory skills specifically needed for the solution of the problem.
4. To encourage cooperative work habits, by working in small groups, and simultaneously encourage independent thinking and working habits through individual assignments.

In a broader sense, the general objectives of science teaching⁵ were guiding principles as well.

The selection of a suitable problem was perhaps the most difficult part of the whole undertaking. The criteria set by our advisory council may help others in choosing their project.

1. Advisor should be well acquainted with the general area of the problem since neither student nor the advisor can be expected to do extensive library research.

¹ Present address: DeBell & Richardson, Hazardville, Conn.

² National Science Teachers Association, "Student Projects." Washington, D. C.: The Association, a Department of the National Education Association, 1958.

³ Schaefer, Donald A. "Advanced Science for Gifted Students." *The Science Teacher*, 25, 269, September 1958.

⁴ Cartelyou, E. & W. P. "National Cooperative Undergraduate Chemical Research Program." *J. Chem. Ed.*, June 1956, 294.

⁵ National Society for the Study of Education. *Rethinking Science Education*. Fifty-Ninth Yearbook, Part I. Chicago: The University of Chicago Press, 1960, 344 pp.

2. The economic situation of the school must be taken into consideration. Projects requiring expensive equipment should be avoided. Funds are usually scarce. There would furthermore be a natural reluctance to place sensitive instruments in the hands of a novice.
3. Short range projects are preferable. The interest of the student will tend to fade with time. There is always the danger of losing some participants due to migration. A project should certainly not extend beyond one school year.
4. A completion of the project should be assured.—To offer guaranteed success may indeed be difficult. Yet, students must have a feeling of accomplishment, if the above objectives are to be achieved. In order to obtain a solution to their research problem, the project should be divided into simple sub-problems. Integration of these minor solutions will yield the desired success.

One of the projects pursued at R.T.M.A. during the 1959–60 academic year involved the color reactions of the isomeric phenylenediamines with common inorganic anions and cations. Each member of the research team was assigned the study of a limited number of ions. Subsequent assignments involved analogous study under a variety of pH conditions. Each member was required to present their observations in neatly tabulated form.⁶ Examination of these results, coupled with a study of relevant literature, revealed that a number of new and useful detection tests for the isomeric phenylenediamines, even in the presence of one another, had been developed. Details of these new tests are being reported elsewhere.⁷ However, the color reactions in these tests are summarized below.

Test Reagent:	Phenylenediamine isomer:		
	ortho	meta	para
$\text{Bi}(\text{NO}_3)_3$	ORANGE	none	none
NaNO_2	none	RED	none
KMnO_4	none	none	BLUE

The advanced science program at R.T.M.A. has thus shown that original scientific research can be carried on by properly supervised high school students. Such a program has furthermore considerable educational value in stimulating scientific attitudes and interests. All of the participants of last year's project have signed up for this year as well.

⁶ See Tables I–VI.

⁷ Hirsch, A., et al., *Chemist-Analyst*, 50, in press (1960).

TABLE I. TESTS ON FILTER PAPER: NO PRIOR pH ADJUSTMENT

	Ortho	Meta	Para
Fe^{+3}	Blue	Blue	Blue
Ca^{+2}	Green	Green	Blue
Ag^+	Blue	Blue	Blue
Sb^{+3}	Pink	—	—
Be^{+2}	Pink	—	—
Sn^{+2}	Pink	—	—
Hg^{+2}	—	—	—
CrO_4^{--}	Yellow	Yellow	Purple
$\text{Cr}_2\text{O}_7^{--}$	—	—	Pink
S^{--}	Lemon	—	—
MnO_4^{--}	Purple	—	Purple
CO_3^{--}	Lemon	—	—
IO_3^{--}	—	—	Blue
OH^{--}	—	—	—
As^{+3}	Green	—	—

TABLE II. TESTS ON FILTER PAPER: (B) AT pH 5
WITH ACETIC ACID

	Ortho	Meta	Para
Fe^{+3}	Orange	—	Blue
Co^{+2}	Lemon	—	—
Cu^{+2}	Green	Brown	Green
Ag^+	Blue	Blue	Blue
Sb^{+3}	Green	Red	Green
Bi^{+3}	Orange	—	—
Sn^{+2}	Grey	—	Grey
Hg^+	—	Orange	—
Hg^{+2}	—	—	Purple
NH_4^+	Grey	—	—
Al^{+3}	—	—	—
CrO_4^{--}	Yellow	Yellow	Purple
$\text{Cr}_2\text{O}_7^{--}$	—	Brown	Blue
NO_2^{--}	Brown	Red	Green
MnO_4^{--}	—	—	Blue
CN^{--}	—	—	—
IO_3^{--}	—	—	Blue

TABLE III. TESTS ON FILTER PAPER: (C) AT pH 8
WITH NH_4OH

	Ortho	Meta	Para
Fe^{+3}	Red	—	Blue
Cu^{+2}	—	—	Blue
Ag^+	Blue	Blue	Blue
Sb^{+3}	Pink	—	—
Bi^{+3}	Pink	—	—
Sn^{+2}	Pink	—	Grey
Hg^+	—	—	—
Hg^{+2}	—	—	—
$\text{CrO}_4^{=}$	Yellow	Yellow	Purple
MnO_4^-	—	—	—
Ni^{+2}	—	—	—
As^{+3}	Green	—	—
$\text{CO}_3^{=}$	Lemon	—	—

TABLE IV. TESTS ON SPOT PLATE: (A) NO PRIOR
pH ADJUSTMENT

	Ortho	Meta	Para
Fe^{+3}	Red	—	Blue
Cu^{+2}	Blue	Green	—
Ag^+	Purple	Purple	Purple
Be^{+3}	—	Purple	Purple
Sn^{+2}	—	—	Flesh
Hg^+	Brown	Yellow	—
Hg^{+2}	—	Yellow	—
$\text{CrO}_4^{=}$	—	—	—
$\text{Cr}_2\text{O}_7^{=}$	—	—	Green
$\text{CO}_3^{=}$	—	—	—
IO_3^-	—	—	—

TABLE V. TESTS ON SPOT PLATE: (B) AT pH 5 WITH
ACETIC ACID

	Ortho	Meta	Para
Fe^{+3}	Red	—	Blue
Cu^{+2}	Green	—	Green
Ag^+	Purple	—	Purple
Sb^{+3}	—	—	Flesh
Hg^+	Brown	Purple	Green
Hg^{+2}	Flesh	—	—
$\text{CrO}_4^{=}$	Black	Brown	Green
$\text{Cr}_2\text{O}_7^{=}$	Brown	Brown	—
NO_2^-	—	Red	—
MnO_4^-	—	—	—
IO_3^-	Brown	Red	Green
ClO_3^-	—	Yellow	—
Ba^{+2}	—	Tan	—

TABLE VI. TESTS ON SPOT PLATE: (C) AT pH 8
WITH NH_4OH

	Ortho	Meta	Para
Fe^{+3}	—	—	—
Co^{+2}	Blue	Blue	Green
Cu^{+2}	Purple	—	—
Ag^{+}	Purple	—	Purple
Bi^{+3}	Pink	—	—
Sn^{+2}	Yellow	—	—
Hg^{+2}	Yellow	—	—
Hg^{+}	—	Purple	—
Ni^{+2}	—	Blue	—
Mn^{+2}	Tan	Tan	Tan
Ca^{+2}	—	—	—
Mg^{+2}	—	—	—
Ba^{+2}	—	—	—

NATIONAL SCIENCE FOUNDATION SUMMER FELLOWSHIPS FOR SECONDARY SCHOOL TEACHERS OF SCIENCE AND MATHEMATICS

As one means of improving the teaching of science and mathematics in American secondary schools, the National Science Foundation plans to award on March 15, 1962 several hundred Summer Fellowships for Secondary School Teachers of Science and Mathematics. Those who receive fellowships must pursue a program of *graduate-level* work in the subject matter of science or mathematics. The fellowships will be awarded to support individually planned programs of study in the mathematical, physical and biological sciences at a level that is acceptable by the fellowship institution toward an advanced degree in any of these subject matter disciplines.

The closing date for receipt of applications is January 2, 1962. Information and application forms will be sent upon request addressed to Secondary School Fellowships, American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

A teacher may apply for fellowship support for one, two, or three summers. Each applicant chooses the college or university at which he wishes to study—there is no list of college and universities selected for this purpose. The fellowship program is completely separate from the NSF summer institute program. It is recommended that a program of study for the period of the fellowship be developed with the assistance of a staff member at the proposed fellowship institution. The program of study is a very important part of the application. Although some colleges and universities will not have announced their course offerings for the summer of 1962 by the deadline date for applications (January 2) the proposed program of study in the application should list specific courses from which the courses for study in the summer of 1962 will be chosen.

Prior teaching experience in a secondary school is required of all applicants, and no exceptions will be made to the requirements outlined in the announcement. Those without the requisite teaching experience and those who must complete undergraduate prerequisites before undertaking a program of graduate-level work should not apply for a fellowship under this program.

Mathematics in High School Biology

Thomas G. Overmire

Ball State Teachers College, Muncie, Indiana

One of the universal bits of advice given to high school students is "Those of you who plan to study science should also plan to study mathematics because 'mathematics is so important in science.' " As a scientist I agree with this whole-heartedly. Yet, as a high school biology teacher, I used to be troubled with the question of how to present the mathematics "that is so important in science" so that its importance would be recognized. The average biology student has completed, at best, one course in high school algebra. The mathematics that is so significant in science and the mathematics that is acquired in freshman algebra is not the same thing. If what the advisors say is true—and it is—then some time in the biology course should be devoted to emphasizing how mathematics is actually used. But this emphasis should be such that the contribution of mathematics may be appreciated without the need for having an extensive mathematical background.

I feel that there are four general ways that the use of mathematics should be stressed in high school biology: (1) in making quantitative measurements, (2) in presenting information, (3) in making estimates, and (4) in validating information. The series of exercises that follows was developed with these four areas in mind.

Area One: MAKING QUANTITATIVE MEASUREMENTS

The first exercise is a series of measurements involving conversions between the metric and English systems. For most students this is a review of junior high school general science; however, the importance of this material makes it worth reviewing.

Exercise No. 1: MEASUREMENTS

The purpose of this exercise is twofold: (1) to give you practice in making scientific measurements, and (2) to let you compare two systems for measuring—the metric system and the English system. You are to find the answers to the following questions through your own observations. Feel free to ask for help if you do not understand how to do something—but remember, this is supposed to be practice for you and not for the teacher!

- (1) How many ml. will a 100 ml. beaker actually hold?
- (2) How many ml. will a test tube hold?
- (3) How many drops are in a cc.?
- (4) How many drops will a teaspoon hold?
- (5) How many cc. are in a full tablespoon?
- (6) How many inches are in a meter?

- (7) How many ml. are in one ounce?
- (8) How many cm. are in one foot?
- (9) How many teaspoons are in a tablespoon?
- (10) How many cm. are in a meter?
- (11) How many grams are in one ounce?
- (12) What is the centigrade temperature of the boiling salt water? the fahrenheit temperature?
- (13) What is the centigrade temperature of the iced salt water? the fahrenheit temperature?
- (14) How much does the rock weigh in grams? in ounces?
- (15) What seem to be the chief advantages and disadvantages of each system?

Careful measurements can be utilized very satisfactorily to illustrate growth patterns. Logarithmic curves and some aspects of the Fibonacci pattern of growth have been incorporated in the following exercise.

Exercise No. 2: GROWTH PATTERNS IN NATURE

Growth in nature follows regular patterns. It is possible to analyze these patterns mathematically. In this exercise we shall examine the growth patterns of a number of common objects such as corn stalks, sea shells, pine cones, horns, tree branches, sunflowers, etc. If our measurements are carefully made we may be able to determine some sort of regular growth patterns.

METHOD: (1) Measure *very carefully* the distance in millimeters between the nodes, scales or ridges of your particular object.

(2) Plot your findings of graph paper and draw the resulting growth curve. What sort of pattern of development seems to be shown?

(3) Compare the curve with the growth curves we have found in our previous experiments with seedlings and mold colonies.

(4) Repeat for as many objects as you have time for.

Area Two: PRESENTING INFORMATION

It is quite important for biology students to learn to prepare, use and understand graphs and tables. Exercise No. 3 involves construction of a graph to show the recovery time of the pulse rate following exercise. Exercise No. 4 makes use of graphs and tables in an analysis of the growth of a population—the population in this case is ten corn plants. Similar practice in presenting data can be based on experimentation with the growth of roots, the gain in weight of mice, radioactive isotope decay curves, etc.

Exercise No. 3: RECOVERY TIME

In this exercise we shall attempt to see how quickly the pulse rate will return to normal after different amounts of exercise. It is

very important that you practice finding your pulse until you are able to locate it quickly. The teacher will demonstrate the proper way to do this.

PROCEDURE: (1) Count your pulse for 15 seconds (the teacher will act as timekeeper). Wait for 15 seconds and then count it again. Repeat this pattern until you have made six 15-second counts. Be sure that you record your results each time.

(2) Under the teacher's direction do three deep-knee-bends. Sit down, immediately find your pulse, and start counting when you are told to do so. Make six 15-second counts as before. Record your results.

(3) Do ten deep-knee-bends. Make six more 15-second counts. Record your results.

(4) Construct a line graph showing your results. Use "Pulse Rate" for one axis (side) of the graph and "Counts" for the other. You may make separate graphs for each of the three trials or you may plot all of the results on one graph. In either case be sure that you tell what each line represents.

QUESTIONS: (1) Is the recovery time proportional to the amount of exercise?

(2) What was the control for this experiment?

(3) Why were 15 second counts made instead of 30 second or one minute counts?

Exercise No. 4: A POPULATION STUDY

In this experiment each student will analyze the growth pattern of a population made up of ten corn plants.

PROCEDURE: (1) Construct a germination "flower bed" out of a blotter and a drinking glass.

(2) Select ten soaked corn seeds and "plant" them in the space between the blotter and the inside wall of the glass.

(3) Put enough water in the bottom of the glass so that the blotter will remain moist all of the time.

(4) Take daily growth measurements and record your data.

PRESENTATION: You will be expected to present your results in both graphs and tables. Some problems you should anticipate include:

(1) Should the measurements be made in centimeters or inches?

(2) What should be done if some of the seeds do not germinate?

(3) How long should the experiment continue?

(4) Should data be presented for each individual plant or for the average of the entire group?

(5) Should the results be tabulated according to daily heights or according to daily increases in heights?

IMPORTANT: You should be prepared to defend the method you choose to conduct your population study!

Area Three: MAKING ESTIMATES

The importance of having accurate ways to make estimates becomes evident to students during the study of such units as bacteriology, ecology and physiology. Exercise No. 5 evaluates a sampling method for estimating the numbers of microbe colonies growing in a petri dish. Other exercises involving estimates might include conducting a bird census, making red blood cell counts, or checking dilution techniques in bacteriology.

Exercise No. 5: ANALYSIS OF A METHOD FOR SAMPLING POPULATIONS

It is not always possible to count the total number of individuals in a population. This exercise illustrates a sampling method that may be used for estimating total numbers.

MATERIALS NEEDED: (1) Checkerboard counting-grids ($\frac{1}{4}$ inch squares in blocks of nine)

(2) Petri dishes that had a 30 minute exposure to air, 48 hours previously.

METHOD: (1) Place your petri dish over the counting grid. Record the number of colonies found in the upper right hand square of each section (Count all of the colonies within or touching the lines of the square). Be careful not to move the petri dish after you have started your count.

(2) Add these numbers and multiply the total by nine to arrive at the *estimated total*.

(3) Make an actual count of all of the colonies growing in the petri dish.

(4) Determine the per cent of error of the estimated total.

$$\text{Per cent error} = \frac{\text{difference between estimated \& actual total}}{\text{actual total}} \times 100$$

(5) Enter your results in the master chart on the blackboard. After the results of the entire class have been recorded, answer the following questions:

(a) What is the average amount of error for the entire class?

(b) Is this sampling method more accurate for large or small numbers?

Area Four: VALIDATING INFORMATION

Use of the scientific method implies the use of valid data. It is important for students to learn some of the ways that information is tested for accuracy. Exercise No. 6 uses standard deviation to analyze variation in tree leaves; Exercise No. 7 uses chi square to examine the

boy-girl ratio of a biology class. Both of the statistical methods are used extensively in biological studies and students should be aware of their significance.

Exercise No. 6: NATURAL VARIATION IN LEAVES

When you start your leaf collections you will be asked to collect "typical" leaves. In order to be able to do this you must first know what "typical" leaves are. In this exercise we shall attempt to: (1) sample the variation in the size of the leaves of a single tree, and (2) analyze this variation in order to see *how* typical leaves must be to be "typical." Recognition of the occurrence of natural variation is necessary for an understanding of such topics as taxonomy, ecology and evolution.

METHOD: (1) Start at the end of a branch and measure the lengths (to the nearest millimeter) of the first ten leaves you come to. Include the petiole in your measurement. Do not be selective (i.e. do not skip around). A leaf should be skipped only if it has been so injured that you are unable to make a proper measurement. Record your results.

- (2) Compute the *mean* (average) length of the 10 leaves.
- (3) Calculate the *standard deviation* according to the following directions:
 - (a) Subtract the mean length from each of the measurements you obtained. This difference is the *deviation* between the average and actual lengths.
 - (b) Square each deviation and add the 10 resulting numbers.
 - (c) Divide the total by 10. The resulting number is called the *variance*.
 - (d) Find the square root of the variance; this number is the *standard deviation*.
- (4) Construct a graph comparing the lengths of the leaves with the frequency of the lengths.
- (5) Mark the mean length on the graph.
- (6) Mark the limits of \pm one standard deviation and \pm two standard deviations from the mean on the graph. (This will be demonstrated.)

QUESTIONS: (A) What per cent of the leaves fall within the limits of \pm one standard deviation from the mean? of \pm two standard deviations?

- (B) If we measured *all* of the leaves on a tree we would find that about 67% of the leaves would be included within the limits of \pm one standard deviation, and about 95% would fall within \pm two standard deviations. Did your sample come out with these results?

- (C) If we assume that all leaves that fall within \pm two standard deviations from the mean are "typical," what per cent of your sample is typical?
- (D) Why is it necessary to count every leaf you come to on a branch? Why can't you pick out the leaves you want to measure?

Exercise No. 7: THE CHI SQUARE METHOD OF ANALYSIS

In order to validate a ratio it is necessary to consider a large number of individuals. In this exercise we are going to "pool" the family information from all of the members of the class to see how closely we approach a 50-50 boy-girl ratio. We shall use a method of evaluation called "chi square."

PROCEDURE: (1) Record the number of boys and girls in your immediate family (including yourself) in the master list on the blackboard. When the master list is complete for the entire class fill out the following chart and determine the chi square value. Chi square will be the number in the lower right-hand space of the chart.

	Boys	Girls	Total	
Observed total ¹				
Ideal total ²				
Deviation ³				
Deviation squared ⁴				
D ² /Ideal total ⁵				←Chi Square

- (2) Find the approximate chi square value in Table I. The corresponding probability value tells how likely it is that the ratio really is 50-50. For instance, if the chi square value is 0.07 there is an 80% probability that the boy-girl ratio is 50-50. In

¹ The totals in the master list on the blackboard.

² The totals you would have if *exactly* one-half of the grand total would be boys and one-half would be girls.

³ The difference between the ideal total and the observed total.

⁴ Line three, squared.

⁵ Line four, divided by line two.

statistical studies, scientists will accept as satisfactory any probability greater than five per cent.

- (3) For tomorrow redetermine the chi square value, after first subtracting the actual number of boys and girls in class from the "observed total." Even though you will be working with smaller numbers, your probability value may be closer to 100% this time—can you tell me why?

TABLE I

Chi Square	0.00	0.02	0.10	0.45	1.32	2.71	3.84	6.63
Probability	99%	90%	75%	50%	25%	10%	5%	1%

SUMMARY

Obviously, it would be impractical to attempt to teach mathematics, as such, in a biology course. Yet, biology students need to be made aware of the importance of mathematics in biology. By emphasizing some of the ways in which mathematics is used, the teacher can broaden the students' concepts of biology. And there is always the possibility that some students may actually decide to take more mathematics so that they may understand biology better!

SUGGESTIONS FOR FURTHER READING

1. ANDERSON, E., 1956, "National history, statistics and applied mathematics." *American Journal of Botany*, 43: 882-9.
2. EDWARDS, P. D., 1953. "The role of mathematics in science." *Proceedings of the Indiana Academy of Science*, 62: 45-51.
3. FERGUSON, IRA L. AND E. S. FERGUSON, 1956. *The Mathematics of Dosages and Solutions for Nurses*. Saunders Co., Philadelphia.
4. GARDNER, ROBERT, 1959. "Mathematics and leaves." *The American Biology Teacher*, 21: 287.
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6. KEMPTHORNE, OSCAR, *et al.*, editors, 1954. *Statistics and Mathematics in Biology*. Iowa State College Press, Ames.
7. KOSTITZIN, V. A., 1939. *Mathematical Biology*. George G. Harrap & Co., London.
8. OVERMIRE, THOMAS G., 1961. "The sixth sense—nonsense?" *The American Biology Teacher*, 23: 139-40.
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10. THOMPSON, D'ARCY, 1942. *On Growth and Form*. MacMillan Co., New York.

MAGNET PRODUCES HIGH MAGNETIC FIELD

A new magnet, capable of producing extremely high magnetic fields, has been developed at Bell Telephone Laboratories. The coiled magnet (solenoid) can maintain magnetic fields of 88,000 gauss, whereas previous solenoids could only produce fields of a few thousand gauss. The solenoid is a niobium (columbium) and tin compound, which does not require much electric energy once the magnetic field is established. The material will have important applications in communications systems where large magnetic fields are required.

Annual CASMT Convention

The sixty-first annual meeting of the Central Association of Science and Mathematics Teachers will be held in Chicago, Sheraton-Chicago Hotel, November 23-25, 1961.

This meeting will feature significant advances in science and mathematics education at the elementary, secondary and college levels.

Of particular interest are the general sessions where speakers of national renown will address the convention. Those presenting the major addresses are:

James A. Van Allen, Professor and Head of Physics Department, University of Iowa, well known for his contribution in the use of rockets and balloons for high altitude research.

H. Stanley Bennett, Dean of the Division of Biological Sciences at the University of Chicago, renowned for his research with the electronic microscopes.

Norman Hilberry, Director of Argonne National Laboratory, who has played an important role in the National Atomic Energy Program since its origin.

Robert A. McCleary, M.D., Associate Professor of Psychology, Chicago University, who is known for his research on the brain and will discuss "How the Brain Controls Fear Behavior."

The regular program is structured to cover the following broad areas:

November 23 *Teaching Strengths Needed for New Horizons*

This will be a panel discussion by a few of the past presidents recognized for their contribution to education.

November 24 Morning Session—*Progress and Future Plans for Experimental Programs*

Eleven experimental programs in science and mathematics will be discussed concurrently by the directors or people actively engaged in the experimental work. This will provide opportunity for participants to select the programs and provide ample time for discussion.

November 24 Afternoon Session—*Practical Classroom Ideas*

During this block of time section meetings will be held in all areas planned by section chairmen who were elected during the last annual meeting.

November 24 Late Afternoon Session—*Content Lectures on Subject Matter*

At this time lectures in both science and mathematics will be given by outstanding college professors on topics of interest to the teacher. These lectures are provided to expand and give greater depth to topics commonly taught in the elementary and secondary schools.

November 25 *New Approaches in Education*

The unusual feature of this section is that each section will pertain to common interests of both science and mathematics. These meetings will be of equal interest to the administrator as well as the teacher. Speakers well known for their work in these areas will be present. There will be sections featuring team teaching, programmed learning, advanced placement programs, supervision, nongraded schools, as well as a demonstration with a group of elementary pupils showing some new approaches in teaching elementary mathematics.

In addition to the section meetings and the general sessions there will be an outstanding display of new teaching materials in science and mathematics.

Additional information about speakers is featured on the following pages.

Keynote Speaker-Friday



DR. H. STANLEY BENNETT

H. Stanley Bennett, Dean of The Division of Biological Sciences of The University of Chicago will be the keynote speaker at the opening meeting on Friday, November 24. The title of his address is *Changing Concepts of the Cell*.

Dr. Bennett received an A.B. degree from Oberlin in 1932 and a degree as a medical doctor from Harvard in 1936.

He was an instructor in pharmacology and associate professor of anatomy at Harvard from 1937 to 1942. Following service as a naval officer until 1948, he carried on research at the Massachusetts Institute of Technology as an associate professor of cytology.

An authority on anatomy, Dr. Bennett is president-emeritus of the American Association of Anatomists. His specialty is cellular anatomy and cyto-chemistry. He is renowned for his research with the electron microscope.

Dr. Bennett was appointed a member of the National Advisory Council to the United States Public Health Service in 1958 and is a diplomate of the National Board of Medical Examiners.

Among his many accomplishments and recognitions is the Legion of Merit awarded in 1952 by the navy. This was in recognition of the achievement of his research team 13-1 which he headed as a captain in the volunteer reserve from 1948 to 1952.

61st ANNUAL CONVENTION
CENTRAL ASSOCIATION
of
SCIENCE AND MATHEMATICS TEACHERS

Featured Speaker-Friday Evening



DR. NORMAN HILBERRY

Dr. Norman Hilberry, Director of the Argonne National Laboratory, will be the speaker for the Friday evening general session, November 24. The title of his address is, "The Role of Science and Mathematics in the Curriculum of the Future."

Dr. Hilberry received a B.S. degree from Oberlin in 1921 and a Ph.D. degree from the University of Chicago in 1941.

He was instrumental in the organization of the University of Chicago-U. S. State Department Cosmic Ray Expedition to South America. In 1941 he attended, as a guest of the Brazilian Government, the symposium on cosmic rays held in Rio de Janeiro by the Brazilian Academy of Sciences.

In 1942, Dr. Hilberry was active on the Plutonium Project and was in a large measure responsible for the rapidity with which the first nuclear chain reaction was established. He has rendered great service to the development of the atomic energy program. He contributed materially to the speed with which the first atomic weapons were constructed and his interest and guidance in the establishment of the national laboratories have played an important role in establishing the position of preeminence of the United States in the atomic energy field.

Dr. Hilberry is a fellow of the American Physical Society, of the New York Academy of Science and of the American Association for the Advancement of Science.

SHERATON-CHICAGO HOTEL

NOVEMBER 23-25, 1961

Featured Speaker-Saturday



DR. JAMES A. VAN ALLEN

Featured at the Saturday General Meeting is James A. Van Allen, Professor and Head of the Physics Department, State University of Iowa. The title of his address is *Physics in Space*.

Dr. Van Allen received a B.S. Degree from Iowa Wesleyan College, A.M.S. and a Ph.D. from the State University of Iowa.

Dr. Van Allen has received national renown for his work with cosmic rays and the use of rockets and balloons for high altitude research. He is the recent discoverer of two high intensity radiation belts surrounding the earth, and which have been named in his honor.

During 1939-42, Dr. Van Allen worked as a research fellow and physicist at the Carnegie Institution, Washington, D. C. In 1946-50, he was located at Johns Hopkins University and during 1953-54, Dr. Van Allen served as Research Associate at Princeton University. Presently he is Professor and Head of the Physics Department, State University of Iowa.

A few of the many honors and achievements of Dr. Van Allen are the C. N. Hickman medal of The American Rocket Society for development of the Aerobee rocket, 1949, the Space Flight Award of the American Astronautical Society, 1958, the Distinguished Civilian Service Medal, U. S. Army, 1959 and the Lewis W. Hill Transportation Award, Institute of Aeronautical Science. He has received Honorary doctor of science degrees from Iow Wesleyan, 1951; Grinnell, 1957; Coe, 1958; Cornell, 1959; and The University of Michigan.

FEATURING:

SIGNIFICANT ADVANCES in SCIENCE and MATHEMATICS EDUCATION

Luncheon Speaker-Saturday



DR. ROBERT A. MCCLEARY

Robert A. McCleary M.D., Associate Professor of Psychology, the University of Chicago will highlight the luncheon on Saturday November 25, 1961. The title of his address is *How the Brain Controls Fear Behavior*.

Dr. McCleary received his A.B. degree from Harvard University, a Ph.D. and a medical degree from Johns Hopkins University.

He has been an instructor in Psychology at Johns Hopkins and associate professor of psychology at the University of Michigan and is presently at the University of Chicago.

Dr. McCleary did research in physiological psychology, School of Aviation Medicine, 1951-53.

During 1957-1958 he was engaged in research in psychological psychology in Oslo, Norway under a Carnegie Post Doctoral Fellowship.

Dr. McCleary is Project Director of U. S. Public Health Service Project B 598 and is a Consultant to U. S. Surgeon General in the area of environmental extremes and behavior.

**MAKE PLANS NOW
TO
ATTEND THE CONVENTION
THIS FALL**

Summary of the Official Minutes
of the
Spring Board Meeting
of the
Central Association of Science and Mathematics Teachers

SHERATON TOWERS HOTEL (now SHERATON-CHICAGO)
APRIL 29-30, 1961

Roll Call:

Officers: Read, Hach, Shetler, Mallinson, Kennedy
Directors: Ambrosia, Clader, Conrey, Hill, Johnson, Keller, Laird, Otto,
Porter, Urbancek, Vannatta, Woline, Wood
Local Arrangements Chairman: Louis Shrode
Place of Meeting Chairman: Hobart Sistler

Minutes of Annual Meeting: The minutes were approved as published in SCHOOL SCIENCE AND MATHEMATICS, March, 1961.

Nominating Committee: Chairman Hill presented the following slate:

President: Miss Alice M. Hach, Ann Arbor, Mich.; Sister Mary Ambrosia, Detroit, Mich.
Vice-President: Dr. Joseph J. Urbancek, Chicago, Ill.; Dr. T. Reginald Porter, Iowa City, Iowa
Directors: Dr. Charles Brumfiel, Ann Arbor, Mich.; Mr. Calvin W. Gale, Madison, Wis.; Dr. Julian Greenlee, Pontiac, Mich.; Dr. E. W. Hamilton, Cedar Falls, Iowa; Mr. Robert R. Hurst, Evanston, Ill.; Rev. Leo J. Klosterman, C.S.B., Detroit, Mich.; Illa Podendorf, Chicago, Ill.; Mr. Bruce Westling, Grosse Pointe, Mich.

Policy and Resolutions Committee: This committee made several suggestions. These resulted in the following Board actions:

CONVENTIONS. The Association will continue its practice of holding conventions in and out of Chicago on alternate years. This is not a rigid policy. The place of meeting for conventions is to be chosen three years prior to the time of the convention. A statement of our requirements on facilities, finance personnel, etc., is to be prepared as a guide to groups desiring a convention. Registration fees are \$1.00 for members and \$2.00 for non-members. A \$1.00 admission for evening or Saturday sessions will be available.

A.A.A.S. AFFILIATION. Although this study is being continued the Board now feels that we should limit our participation to programs held in our primary area.

BY-LAWS. To clarify Article III, Officers, Section 2, Qualifications, the following interpretation is made. First, the word "Officers" refers to the officers of the Association named in Article III, Section 1 and next, the "past five years" refers to the five years preceding July 1 prior to the annual meeting at which the election is to be announced.

BUDGET. Requests for funds in excess of those budgeted shall be submitted to the President. The Executive Committee is empowered to approve or disapprove such requests.

POLICY HANDBOOK. A handbook summarizing the policies of the Association is to be prepared.

JOURNAL COMMITTEE. This committee is to meet before the annual business meeting to review suggestions and services that can be rendered to the Editor. A written report is to be distributed to the Directors by November 1, 1961.

Treasurer and Business Manager: The business office is now completely moved to Bluffton, Ohio. The following budget was approved for the fiscal year 1961-1962.

BUDGET FOR 1961-1962

Income:

Memberships and subscriptions.....	\$25,000
Journal advertising.....	5,000
Back number sales.....	500
Reprint sales.....	200
Interest on investments.....	200
Convention incomes.....	
YEARBOOK profit.....	100
Registration fees.....	1,300
	<hr/>
	\$32,300

Expenditures:

Audit.....		\$ 200
Journal printing.....		20,000
Salaries.....		5,400
Business Manager.....	\$2,400	
Editor.....	1,500	
Secretary.....	1,500	
Business Office expense.....		1,200
Secretary expense.....		1,200
Editorial expense.....		300
President's expense.....		200
Spring Board Meeting and committees.....		600
Stationery, forms, printing.....		600
Electric costs.....		200
Convention costs.....		
Total Arrangements Chairman.....	500	
Program Chairman.....	600	
Treasurer and Business Manager hotel.....	100	
		<hr/>
		1,200
Contingency fund.....		1,200
		<hr/>
		\$32,000

Place of Meeting Committee: The 1962 convention will be held in St. Louis.

Reappointment of Officers: The Editor, Secretary, and Treasurer and Business Manager were reappointed for three-year terms. These terms begin: July 1, 1960; April 30, 1961; and July 1, 1961, respectively.

Resignation of Director: Warren Woline will be a Fulbright Exchange teacher next fall. His resignation was regretfully accepted and Louis Shrode was appointed to fill the unexpired term.

Please contact the Secretary if additional information on any Board action is desired.

JOE KENNEDY
Secretary, CASMT

Problem Department

Conducted by Margaret F. Willerding

San Diego College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problem should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution as on the following pages.

The editor of the Department desires to serve her readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solution should observe the following instructions.

1. Solutions should be in typed form, double spaced.
2. Drawings in India ink should be on a separate page from the solution.
3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.
4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2759. J. A. H. Hunter, Toronto, Ont., Canada.

2761. Mary Scholder, Brooklyn, N. Y.

2765, 2772. Brother Norbert, Cleveland, Ohio.

2769, 2759. Brother Alfred, St. Mary's College, Calif.

2764. Clyde McDaniel, Norfolk, Va.

2772. Margaret St. Onge, Quebec City, Canada.

2773. No solution has been offered.

2774. Proposed by Ned Harrell, San Carlos, Calif.

Find integers x , y and z such that

$$x(2 \log 105 + \log 1215) + y(3 \log 105 + \log 875) - z(2 \log 105 + \log 45) + \log 3 = 0.$$

Solution by Herbert R. Leifer, Pittsburg, Pa.

$x(2 \log 105 + \log 1215) + y(3 \log 105 + \log 875) - z(2 \log 105 + \log 45) + \log 3 = 0$
may be written as

$$x(\log 105^2 \cdot 1215) + y(\log 105^3 \cdot 875) + \log 3 = z(\log 105^2 \cdot 45)$$

or

$$x \log 3^2 5^2 7^2 + y \log 3^2 5^2 7^4 + \log 3 = z \log 3^2 5^2 7^2,$$

and

$$\log 3^{2x} 5^{2x} 7^{2x} + \log 3^{2y} 5^{4y} 7^{4y} + \log 3 = \log 3^{2z} 5^{2z} 7^{2z}.$$

Then

$$37x+4y+15z+4y=3+57z.$$

Thus

$$7x+3y+1=4z, \quad 3x+6y=3z, \quad \text{and} \quad 2x+4y=2z.$$

From these equations, if r = any integer, we find the following integral solutions:

$$x=3+5r, \quad y=2+3r, \quad \text{and} \quad z=7+11r.$$

Solutions were also submitted by Brother Alfred, St. Mary's College, Calif.; Merrill Barnebey, Grand Forks, N. D.; Anthony De Gennaro, Oberlin, Ohio; J. Byers King, Denton, Md.; Fred A. Miller, Elkins, W. Va.; Brother Norbert, Cleveland, Ohio; Carlos C. Shaw, Rosario, Argentina; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; and the proposer.

2775. Proposed by C. W. Trigg, Los Angeles City College.

For what values of x is $3x^7 - 259$ divisible by 547?

Solution by the Proposer

If $3x^7 - 259$ is divisible by 547 then $3x^7 - 259 + 547$ or $3(x^7 + 96)$ and $x^7 + 96$ are divisible also. It follows that there will be a solution such that $-48 < x < 48$. The only values of x within this range such that $x^7/547$ has a remainder of ± 96 are $-15, 5$, and 45 . Hence, the values sought are $5 \pm 547k, 45 \pm 547k$ and $532 \pm 547k$, k any integer.

A solution was also submitted by Merrill Barnebey, Grand Forks, N. D.

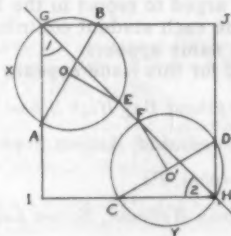
2776. Proposed by Fred L. Bedford, Phoenix, Ariz.

Given any four points, draw lines through the four points so that the four lines will form a square.

Solution by William P. Hearne, Chicago, Ill.

Given any four points such as A, B, C, D

Draw lines through the four points so that the four lines will form a square.



Construction:

1. Using AB as diameter construct circle with center O .
2. Vertex of square will lie on arc AXB .
3. Draw a perpendicular bisector to AB cutting circle O at point E .
4. E will be on diagonal of square.
5. Using CD as diameter construct circle with center O' .
6. Vertex of square will lie on arc CYD .
7. Draw a perpendicular bisector to CD cutting circle O' at point F .
8. F will lie on diagonal of square.
9. Join points E and F and continue line cutting circles O and O' on points G and H .
10. GH is one diagonal
11. Complete the square $GHIJ$.

Proof:

1. Angle 1 = angle 2 = 45° therefore $GI = HI$, etc.
2. Angle $G = \text{Angle } I = \text{Angle } H = \text{Angle } J = 90^\circ$.

Solutions were also submitted by Louis Hall, Bloomington, Ind.; Sarane R. Loeb, Chicago, Ill.; and Lowell Van Tassel, San Diego, Calif.

2777. *No correct solution has been offered.*

2778. *Proposed by Felix John, Philadelphia*

Find two numbers whose sum, whose product and the difference of whose squares are all equal.

Solution by Herbert R. Leifer, Pittsburgh, Pa.

Let a and b be the numbers, then $a+b=ab=a^2-b^2$. From $a+b=a^2-b^2$, $b=a-1$. Using this value for b in $a+b=ab$, we readily find

$$a = (3+\sqrt{5})/2, \quad b = (1+\sqrt{5})/2$$

and

$$a = (3-\sqrt{5})/2, \quad b = (1-\sqrt{5})/2.$$

Solutions were also submitted by Phillip Anderson, Muskegon Heights, Mich.; Merrill Barnebey, Grand Forks, N. D.; Donald R. Byrkit, West Chicago, Ill.; Sister Rose Christina, Tampa, Fla.; Harold Fletcher, Atlanta, Ga.; Louis J. Hall, Bloomington, Ind.; J. Byers King, Denton, Md.; O. F. McCrary, Raleigh, N. C.; Clyde McDaniel, Norfolk, Va.; Brother Norbert, Cleveland, Ohio; Carlos C. Shaw, Rosario, Argentina; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; Eugene Weber, Ft. Jennings, Ohio; and the proposer.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

The Student Honor Roll for this issue appears below.

2764. *Florence Wishko, Sheepshead Bay High School, Brooklyn, N. Y.*

2765. *D. Rameswar Rao, Secundrabad, Andhra Pradesh, India.*

2765. *Norman Neff, Philadelphia, Pa.*

2767, 2774, 2775, 2778. *Martin Hoffman, Boston Latin School, Boston, Mass.*

2774, 2775. *Thomas R. Curry, Bay Shore, N. Y.*

2775. *James Duczynski, Central Catholic High School, Reading, Pa.;*

2778. *Charles Loch, Allegheny High School, Pittsburgh, Pa.*

2778. *Sally Wickham, Regina Dominican High School, Wilmette, Ill.*

PROBLEMS FOR SOLUTION

2797. *Proposed by H. C. Torreyson, Prospect Heights, Ill.*

If z is the number of final zeros in $10^n!$ determine the values of n for which the formula

$$z = 10^n/4 - 1$$

is true.

2798. *Proposed by Brother Felix John, Philadelphia, Pa.*

If M and N are two consecutive numbers each containing n digits and neither number is a multiple of 3, show that the $2n$ -digit number formed by putting M and N together thus, $(M)(N)$, or thus, $(N)(M)$, is a multiple of 3.

2799. *Proposed by Brother Alfred, St. Mary's College, Calif.*

Determine the smallest number divisible by 41 and having the sum of its digits equal to 41.

2800. *Proposed by John Kinloch, Nashville, Tenn.*

Find a recursive formula for the sum of the k th powers (k a positive integer) of the first N integers.

2801. *Proposed by Donald R. Byrkit, West Chicago, Ill.*

In the following addition problem, each letter represents a unique digit. Find each digit.

$$\begin{array}{r} F O R T Y \\ T E N \\ T E N \\ \hline S I X T Y \end{array}$$

2802. *Proposed by C. W. Trigg, Los Angeles City College, Los Angeles, Calif.*

While wandering down an arroyo, a hobo comes upon a horizontal cylindrical culvert, 6.0 feet in diameter and 32 feet long, at eye level. What is the minimum speed with which he may throw a stone through the culvert without touching the culvert?

Books and Teaching Aids Received

BIOLOGY

CELL FUNCTION, by L. L. Langley, *Professor of Physiology, University of Alabama*. Cloth. $22\frac{1}{2} \times 15\frac{1}{2}$ cm. 377 pages. 1961. Reinhold Publishing Corporation, 430 Park Ave. New York 22, N. Y. Price \$7.50.

HIGH SCHOOL BIOLOGY, Green Version-The Laboratory. Paper. $27\frac{1}{2} \times 21\frac{1}{2}$ cm. 1961. American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder.

HIGH SCHOOL BIOLOGY, Green Version-Text $27\frac{1}{2} \times 21\frac{1}{2}$ cm. 1961. American Institute of Biological Sciences Curriculum Study, University of Colorado, Boulder.

HIGH SCHOOL BIOLOGY, Laboratory Block on Plant Growth and Development, Paper. $27\frac{1}{2} \times 21\frac{1}{2}$ cm. 1961. American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder.

HIGH SCHOOL BIOLOGY, Yellow Version-The Laboratory (Teacher's Guide) Paper $27\frac{1}{2} \times 21\frac{1}{2}$ cm. 1961. American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder.

HIGH SCHOOL BIOLOGY, Green Version-The Laboratory (Teacher's Guide) Paper. $27\frac{1}{2} \times 21\frac{1}{2}$ cm. 1961. American Institute of Biological Sciences, Biological Sciences Curriculum Study, University of Colorado, Boulder.

HUMAN HEREDITY, by Jean Rostand, Cloth. $18\frac{1}{2} \times 11$ cm. 135 pages. 1961. Philosophical Library, Inc. 15 East 40th Street, New York 16, N. Y. Price \$4.75.

- A SIMPLIFIED METHOD OF DROSOPHILA, CULTURE FOR THE CLASSROOM, by C. Jack Bennett, *Department of Biological Sciences, Northern Illinois University*. Paper. $28 \times 21\frac{1}{2}$ cm. 4 pages. 1961. Educational Bulletin Service, Northern Illinois University, DeKalb, Illinois.
- THE PLANT COMMUNITY, by Herbert C. Hanson, *Research Professor of Ecology, Catholic University of America, Washington D. C.* and Ethan D. Churchill, *Cornell Aeronautical Laboratory, Inc. Combat Surveillance Project, Arlington, Va.* Cloth $22\frac{1}{2} \times 15$ cm. 218 pages. 1961. Reinhold Publishing Corporation, 430 Park Ave. New York 22, N. Y. Price. \$4.95.
- THE MOLDS AND MAN, by Clyde M. Christensen, *Professor of Plant Pathology, University of Minnesota*. Paper. $21\frac{1}{2} \times 14$ cm. 238 pages. 1961. University of Minnesota Press, Minneapolis 14, Minnesota. Price \$1.75.
- LABORATORY STUDIES IN GENERAL BOTANY, by William M. Carlton, *Associate Professor of Botany, University of Georgia*. Paper. 28×21 cm. 1961. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y. Price \$4.50.
- JOB FUTURES FOR GIRLS IN BIOLOGY Paper 27×10 cm. 1961. 7 pages. United States Department of Labor, Women's Bureau, Washington 25, D. C.
- ASPECTS OF ZOOLOGY, A BIOLOGY OF CRUSTACEA, by James Green, Cloth. 1961. 180 pages. Quadrangle Books, Inc. 119 W. Lake Street, Chicago 1, Ill. Price \$5.75. $21\frac{1}{2} \times 13\frac{1}{2}$ cm.
- GENERAL BIOLOGY, Revised, by Willis H. Johnson, Richard A. Laubengayer, Louis E. DeLanney, *Wabash College*. Cloth. $24\frac{1}{2} \times 17\frac{1}{2}$ cm. 1961. Holt, Rinehart & Winston, Inc. 383 Madison Ave., New York 17, N. Y. Price \$7.95.
- HOW TO KNOW THE FERNS, by Frances Theodora Parsons. Paper. 12.5×19.5 cm. 215 pages. 1961. Dover Publications, 180 Varick Street, New York 14, N. Y. Price \$1.25.
- INSECT LIFE AND INSECT NATURAL HISTORY, by S. W. Frost. Paper. 12.5×19.5 cm. 526 pages. Dover Publications; 180 Varick Street, New York 14, N. Y. Price \$2.25.
- HOW TO KNOW THE AMERICAN MARINE SHELLS, by R. Tucker Abbot. Paper. 10×16 cm. 222 pages. 1961. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, New York. Price \$.75.
- BIOLOGY THROUGH MICROBES: A LABORATORY GUIDE, by Alfred S. Sussman. Paper. 19×26 cm. 202 pages. 1961. The University of Michigan Press, Ann Arbor, Michigan. Price \$3.95.
- THE ENCYCLOPEDIA OF THE BIOLOGICAL SCIENCES, edited by Peter Gray, *Head, Department of Biological Sciences, University of Pittsburgh*. Cloth. 16×23 cm. Pages xxi 1119. 1961. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y. Price \$20.00.
- BIOLOGICAL EDUCATION IN AMERICAN SECONDARY SCHOOLS 1890-1960, by Paul DeHart Hurd, *Stanford University*. Cloth. 14.5×22 cm. Pages ix+263. 1961. American Institute of Biological Sciences, 2000 P Street, N.W. Washington, D. C. Price \$4.75.

CHEMISTRY

- APPROACH TO CHEMISTRY, edited by G. H. Aylward and F. S. Symes. Cloth. $21\frac{1}{2} \times 13\frac{1}{2}$ cm. 248 pages. 1961. The University of New South Wales, Sydney, Australia.
- CHEMISTRY, AN EXPERIMENTAL SCIENCE. Paper. 28×20 cm. 1961. University of California.

- CHEMISTRY, AN EXPERIMENTAL SCIENCE—LABORATORY MANUAL. Volume 1. Paper. 28×20 cm. 1961. University of California.
- CHEMISTRY, AN EXPERIMENTAL SCIENCE—LABORATORY MANUAL, Volume 2. Paper. 28×20 cm. 1961. University of California.
- CHEMISTRY, AN EXPERIMENTAL SCIENCE, Volume 2. Paper. 28×20 cm. 1961. University of California.
- CHEMISTRY, AN EXPERIMENTAL SCIENCE, Volume 1. Paper. 28×20 cm. 1961. University of California.
- ESSENTIALS OF CHEMISTRY IN THE LABORATORY, by Harper W. Frantz, *Professor of Chemistry, Pasadena City College*, and Lloyd E. Malm, *Professor of Chemistry, University of Utah*. Paper. 25½×18½ cm. 308 pages. 1961. W. H. Freeman and Co., 660 Market Street, San Francisco 4, California, Price \$3.30.
- CHEMISTRY FOR THE SPACE AGE, by Dr. Dan Q. Posin, *De Paul University, Professor, Physical Sciences Course*. Cloth. 16.5×21 cm. Pages xiii+680. 1961. J. B. Lippincott Co., 227 S. Sixth Street, Boston 6, Mass.
- CHEMICAL PROPERTIES AND IDENTIFICATION OF IONS, by Omer K. Whipple, *California State Polytechnic College*. Paper. 14.5×20.5 cm. Pages vii+310. 1961. Wadsworth Publishing Company, Inc., San Francisco, California.

PHYSICS

- THE IMPACT OF THE NEW PHYSICS, by Frank Hinman. Cloth. 21½×13½ cm. 1961. 174 pages. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price \$4.50.
- CAREERS AND OPPORTUNITIES IN PHYSICS, by Philip Pollack. Cloth 20½×13 cm. 158 pages. 1961 E. P. Dutton & Co., 300 Park Ave., South, New York 10, N. Y. Price \$3.75.
- FUNDAMENTALS OF UHF, by Allan Lytel, *Director of Publications, Electronics and Ordnance Division, AVCO Corp.* Paper. 23×13½ cm. 1961. 153 pages. John F. Rider Publisher, Inc. 116 W. 14th Street, New York, N. Y. Price \$3.90.
- HOW TO SOLVE PHYSICS PROBLEMS, by Edwin M. Ripin, *Physical Sciences Editor, Collier's Encyclopedia*. Paper. 13×20.5 cm. 112 pages. 1961. John F. Rider Publisher, Inc., 116 W. 14th Street, New York, N.Y. Price \$1.80.
- HOW TO LOCATE AND ELIMINATE RADIO AND TV INTERFERENCE, by Fred D. Rowe, *Chief Investigator, Radio Interference Division, Northern California Electrical Bureau*. Paper. 13×20.5 cm. 168 pages. 1961. John F. Rider Publisher, Inc., 116 W. 14th Street, New York, N. Y. Price \$2.90.
- ELECTRONIC TECHNOLOGY SERIES. Both paper. Both 13×20.5 cm. 1961. John F. Rider Publisher, Inc., 116 W. 14th Street, New York, N. Y.
- TRANSFORMERS, by Alexander Schure, 88 pages. Price \$2.00.
- FILTERS AND ATTENUATORS, by Alexander Schure. 96 pages. Price \$2.25.
- PHYSICS FOR THE SPACE AGE, by Richard W. Schulz and Robert T. Lagemann. Cloth. 15×21 cm. Pages xiii+465. 1961. J. B. Lippincott Company, 227 S. Sixth Street, Boston 6, Massachusetts.
- EXPERIMENTS AND EXERCISES IN PHYSICS, by John W. Renner and Harry B. Packard. Paper. 1961. 19×29 cm. 176 pages. J. B. Lippincott Company, 227 S. Sixth Street, Boston 6, Mass.

MATHEMATICS, COLLEGE

- ESSENTIALS OF MATHEMATICS, by Russell V. Person, *Professor of Mathematics, Capitol Radio Engineering Institute*. Cloth. 23×14½ cm. 646 pages. 1961. John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. Price \$7.00.

- COLLEGE BUSINESS MATHEMATICS, by R. Robert Rosenberg, *Educational Consultant Board of Education, Jersey City, New Jersey*. Cloth. $23 \times 14\frac{1}{2}$ cm. 420 pages. 1961. Gregg Publishing Division, McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. Price \$5.50.
- THE FOURTEEN SYSTEMS OF UNITS, by William R. Varner, *Professor of Physics, Oregon State College*. Cloth. $20\frac{1}{2} \times 13$ cm. 159 pages. 1961. Vantage Press, Inc., 120 W. 31 Street, New York 1, N. Y. Price \$3.95.
- ARITHMETIC FOR COLLEGE STUDENTS, by L. J. Adams, *Santa Monica City College*. Cloth. 21×13 cm. 262 pages. 1961. Holt, Rinehart and Winston, Inc. 383 Madison Ave. New York, N. Y. Price \$3.75.
- UNDERSTANDING BASIC MATHEMATICS, by Leslie H. Miller, *Ohio State University*. Cloth. 23×15 cm. 499 pages. 1961. Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N. Y. Price \$6.25.
- ELEMENTS OF MATHEMATICAL STATISTICS, by Howard W. Alexander, *Earlham College, Richland, Indiana*. Cloth. $23 \times 14\frac{1}{2}$ cm. 367 pages. 1961. John Wiley & Sons, Inc., 440 Park Ave., South, New York 16, N. Y. Price \$7.95.
- ADVANCED CALCULUS, by Watson Fulks, *Professor of Mathematics, Oregon State University*. Cloth. $23 \times 14\frac{1}{2}$ cm. 521 pages. 1961. John Wiley & Sons, Inc., 440 Park Avenue, South, New York 16, N. Y. Price \$11.25.
- COLLEGE ALGEBRA, by Paul K. Rees, *Professor of Mathematics, Louisiana State University*, and Fred W. Sparks, *Professor of Mathematics, Texas Technological College*. Cloth. $23\frac{1}{2} \times 16$ cm. 428 pages. 1961. McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, New York. Price \$6.50.
- CONVEX FIGURES, by I. M. Yaglom & V. G. Boltyanskii, Translated by Paul J. Kelly and Lewis F. Walton, *University of California, Santa Barbara*. Cloth. $23\frac{1}{2} \times 15$ cm. 301 pages. 1961. Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York 17, N. Y. Price \$4.75.
- PROBABILITY, by Frederick Mosteller, *Harvard University*, Robert E. K. Rourke, *Kent School*, George B. Thomas, Jr., *Massachusetts Institute of Technology*. Cloth. 23×15 cm. 319 pages. 1961. Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Price \$5.00.
- ELEMENTARY MATHEMATICAL ANALYSIS, by A. E. Labarre, Jr., *Department of Mathematics, University of Idaho*. Cloth. $23 \times 14\frac{1}{2}$ cm. 706 pages. 1961. Addison-Wesley Publishing Co, Inc., Reading, Massachusetts. Price \$7.75.
- BASIC CONCEPTS IN MODERN MATHEMATICS, by John E. Hafstrom, *Department of Mathematics and Engineering, University of Minnesota, Duluth*. Cloth. $23 \times 14\frac{1}{2}$ cm. 195 pages. 1961. Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Price \$5.75.
- ALGEBRA WITH APPLICATIONS TO BUSINESS AND ECONOMICS, by Paul H. Daus, *Department of Mathematics, University of California* and William M. Whyburn, *Department of Mathematics, University of North Carolina*. Cloth. $23 \times 14\frac{1}{2}$ cm. 354 pages. Addison-Wesley Publishing Company, Inc Reading, Massachusetts. Price \$6.75.
- PROBABILITY WITH STATICAL APPLICATIONS, by Frederick Mosteller, *Harvard University*, Robert E. K. Rourke, *Kent School*, George B. Thomas, Jr., *Massachusetts Institute of Technology*. Cloth. $23 \times 14\frac{1}{2}$ cm. 478 pages. 1961. Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Price \$6.50.
- PRINCIPLES AND PROBLEMS IN COLLEGE BUSINESS MATHEMATICS—A text-work-book, by R. Robert Rosenberg, *Educational Consultant, Board of Education*,

Jersey City, N. J. Paper. 1961. 28×20½ cm. 220 pages. Gregg Publishing Division, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 26, N. Y. Price \$3.00.

FUNDAMENTAL MATHEMATICS, by Thomas L. Wade, *Florida State University*, and Howard E. Taylor, *Florida State University*. Cloth. 15×21 cm. Pages 428. 1961. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price \$6.75.

CALCULUS, AN INTRODUCTORY APPROACH, by Ivan Niven, *Professor of Mathematics, The University of Oregon*. Cloth. 14.5×21 cm. 172 pages. 1961. D. Van Nostrand Company, Inc. 120 Alexander Street, Princeton, N. J. Price \$4.75.

UNIFIED CALCULUS AND ANALYTIC GEOMETRY, by Earl D. Rainville, *University of Michigan*. Cloth. 14×23.5 cm. 1961. Pages xviii+724. The Macmillan Company, 60 Fifth Avenue, New York 11, New York. Price \$8.50.

ELEMENTS OF STATISTICAL INFERENCE, by R. M. Koxelka, *Williams College*. Cloth. 14.5×23 cm. Pages x+150. 1961. Addison-Wesley Publishing Company, Inc., Reading, Massachusetts. Price \$5.00.

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MODERN PLANE TRIGONOMETRY, by William L. Hart, *University of Minnesota*. Cloth. 14.5×23.5 cm. Pages 239+124. 1961. D. C. Heath and Company, 285 Columbus Ave. Boston, Massachusetts. Price \$5.25.

MATHEMATICS ELEMENTARY

NUMBER PRINCIPLES AND PATTERNS, by Allene Archer, *State Teachers College, Towson, Maryland*. Paper. 23×15½ cm. 65 pages. Ginn and Co., Statler Building, Boston 17, Massachusetts. Price \$.76.

EXTENDING MATHEMATICAL IDEAS, by John L. Marks, James R. Smart and Irene Sauble. Paper. 28×21 cm. 96 pages. 1961. Ginn and Co., Statler Building, Boston 17, Massachusetts. Price \$.64.

IMPROVING MATHEMATICS PROGRAMS, by M. Vere DeVault, *University of Texas*. Cloth. 28½×21 cm. 1961. 552 pages. College Division, Charles E. Merrill Books, Inc., Columbus, Ohio.

MATHEMATICS, SECONDARY

ADVANCED HIGH SCHOOL MATHEMATICS, by Glen D. Vannatta, *Chairman, Mathematics Department, Broad Ripple High School, Indianapolis, Indiana*, Walter H. Carnahan, *Former Consultant in Mathematics, State of Indiana*, Harold P. Fawcett, *Ohio State University*. Cloth. 23×14½ cm. 420 pages. 1961. Charles E. Merrill Books, Inc., 1300 Alum Creek Drive, Columbus 16, Ohio. Price \$4.96.

ALGEBRA, FIRST COURSE, by John R. Mayor, *American Association for Advancement of Science and The University of Maryland*, Marie S. Wilcox, *Head of Mathematics Department, Thomas Carr Howe High School, Indianapolis, Indiana*. Cloth. 23×14½ cm. 440 pages. 1961. Prentice-Hall, Inc., Englewood Cliffs, N. J. Price \$4.24.

MODERN ALGEBRA, FIRST COURSE, by Richard E. Johnson, *University of Rochester, Rochester N. Y.* Lona L. Lendsey, *Oak Park and River Forest High School, Oak Park, Ill.* William E. Slesnick, *St. Paul's School, Concord, New Hampshire*. Cloth. 23×14½ cm. 629 pages. 1961. Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. Price \$5.28.

MATHEMATICS REVIEW EXERCISES, by David P. Smith, Jr. & Leslie T. Fagan, *Lawrenceville School*. Cloth. 377 pages. 1961. Ginn and Co., Statler Building, Boston 17, Massachusetts. Price \$4.24. 23×15 cm.

MODERN TRIGONOMETRY, by William A. Rutledge and John A. Pond. Cloth. 13.5×19.5 cm. Pages xii+242. 1961. Prentice-Hall, Inc., Englewood Cliffs, N. J. Price \$4.95.

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ARITHMETIC: AN INTRODUCTION TO MATHEMATICS, by L. Clark Lay, *Orange County State College*. Cloth. 16×25 cm. Pages 321+xiii. 1961. The Macmillan Company, 60 Fifth Ave., New York 11, New York. Price \$4.50.

MATHEMATICS, MISCELLANEOUS

SYNOPSIS FOR MODERN SECONDARY SCHOOL MATHEMATICS, issued by O.E.E.C. Paper. 24×15½ cm. 310 pages. 1961.

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VECTORS IN THREE DIMENSIONAL GEOMETRY, by Abraham M. Glicksman, *The Bronx High School of Science, New York, N. Y.* Paper. 23×15 cm. 46 pages. 1961. National Council of Teachers of Mathematics, 1201 Sixteenth Street, N.W., Washington 6, D. C. Price \$1.20.

THE SOLUTION OF EQUATIONS IN INTEGERS, by A. O. Gelfond. Translated from the Russian by J. B. Roberts. Paper. 20½×13½ cm. 63 pages. W. H. Freeman and Co., 600 Market St., San Francisco 4, Calif. Price \$1.00.

SECRET CODES, REMAINDER ARITHMETIC, AND MATRICES, by Lyman C. Peck, *Ohio Wesleyan University, Delaware, Ohio*. Paper. 23×15 cm. 54 pages. 1961. National Council of Teachers of Mathematics, 1201 Sixteenth Street, N.W., Washington 6, D. C. Price \$1.00.

DIGITAL COMPUTERS AND RELATED MATHEMATICS, by Frederick H. Young, *Montana State University, Missoula, Montana*. Paper. 23×16 cm. 40 pages. 1961. Ginn and Co., Statler Building, Boston 17, Massachusetts. Price \$.80.

A MODERN VIEW OF GEOMETRY, by Leonard M. Blumenthal, *University of Missouri*. Paper. 20½×13½ cm. 191 Pages. 1961. W. H. Freeman & Co., 660 Market Street, San Francisco 4, Calif. Price \$2.25.

SETS, LOGIC AND AXIOMATIC THEORIES, by Robert R. Stoll, *Oberlin College*. Paper. 20½×13½ cm. 206 pages. 1961. W. H. Freeman & Co., 660 Market Street, San Francisco 4, California. Price \$2.25.

MATHEMATICAL INDUCTION, by Leon Henkin, *University of California, Berkeley*. Paper. 25½×17½ cm. 21 pages. The Mathematical Association of America, University of Buffalo, Buffalo 14, N. Y.

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BASIC MATHEMATICS, by Norman H. Crowhurst, *Engineering Consultant*, Paper. 25×15 cm. 144 pages. 1961. John F. Rider Publisher, Inc., 116 W. 14th Street, New York, N. Y. Price \$3.90.

INSERVICE EDUCATION OF HIGH SCHOOL MATHEMATICS TEACHERS, Prepared by Kenneth E. Brown & Daniel W. Snader, *Specialists for Mathematics*, Paper. 1961. 108 pages. United States Printing Office, Office of Education, Washington 25, D. C. Price \$.50. 23×14½ cm.

CHALLENGING AND SOLVING THE "3 IMPOSSIBLES," by Maurice Kidjel in collaboration with Kenneth W. K. Young. Paper. 1961. 40 pages. Kidjel Ratio Division of the Hawaii Art Publishing Co. Ltd., of Honolulu, Hawaii, U.S.A. 23×15 cm.

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BASIC ANALYSIS, by Stephen P. Hoffman, *Trinity College*. Cloth. 1961. 23½×15 cm. 459 pages. Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York 17, N. Y. Price \$6.50.

MAA FILM MANUAL No. 2, THEORY OF LIMITS, by E. J. McShane. Paper. 16.5×24 cm. 31 pages. 1961. The Mathematical Association of America, University of Buffalo, Buffalo 14, N. Y. Price \$1.00.

THE TEACHING OF ARITHMETIC, by Herbert F. Spitzer, *State University of Iowa*. Cloth. 13.5×21 cm. Pages vii+352. 1961. Houghton Mifflin Company, 2 Park Street, Boston, Massachusetts. Price \$5.00.

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COMPUTER PROGRAMMING FUNDAMENTALS, by Herbert D. Leeds and Gerald M. Weinberg. Cloth. 14.5×21 cm. Pages ix+368. 1961. McGraw-Hill Book Company, Inc. 330 W. 42nd Street, New York 36, N. Y. Price \$6.00.

SCIENCE, ELEMENTARY

MODERN ELEMENTARY SCHOOL SCIENCE, by Willard J. Jacobson, *Associate Director, Science Manpower Project* and Harold E. Tannenbaum, *Fellow of the Science Manpower Project*. Paper. 21×13½ cm. 1961. 194 pages. Bureau of Publications, Teachers College, Columbia University, N. Y. Price \$2.25.

WESTERN BUTTERFLIES, by Arthur C. Smith. Cloth. 18×21 cm. 20 pages. 1961. Lane Book Company, Menlo Park, California. Price \$2.95.

SCIENCE, MISCELLANEOUS

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- SCIENCE AND EDUCATION, A POLICY STATEMENT, issued by Science Masters' Assn. & Assn. of Women Science Teachers. Paper. 21×14 cm. 1961. 12 pages. John Murray.
- SCIENCE AND EDUCATION, BIOLOGY FOR GRAMMAR SCHOOLS, issued by S.M.A. and A.W.S.T. Paper. 21×14 cm. 1961. 24 pages. John Murray.
- SCIENCE AND EDUCATION, PHYSICS FOR GRAMMAR SCHOOLS, issued by S.M.A. and A.W.S.T. Paper. 21×14 cm. 1961. 39 pages. John Murray.
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- SCIENCE, DISCOVERY AND PROGRESS, by Ira C. Davis, *Professor in Teaching of Science, University of Wisconsin*, John Burnett, *teacher of Junior High School Science, Superintendent of Schools in Rutland Northeast School District, Pittsford, Vermont*, E. Wayne Gross, *former teacher of science in Junior and Senior High School, University School, Bloomington, Indiana*, Olcott Gardner, *teacher of high school sciences in Jamesville DeWitt High School, DeWitt, N. Y.* Cloth. 1961. $23\frac{1}{2} \times 15\frac{1}{2}$ cm. 595 pages. Holt, Rinehart & Winston, Inc. 383 Madison Avenue, New York, N. Y.
- MODERN EARTH SCIENCE, by William L. Ramsey, *Head of Science Department of Helix High School, LaMesa, California*, Raymond E. Burckley, *Chairman of Science Department of Hicksville High School, Hicksville, N. Y.* Cloth. $24 \times 15\frac{1}{2}$ cm. 630 pages. 1961. Holt, Rinehart & Winston, Inc. 383 Madison Ave., New York, N. Y.
- ESSENTIALS OF LIGHT, by F. J. H. Dibdin, *Senior Lecturer in Physics, College of Technology, Belfast*. Cloth. 1961. 240 Pages. Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London, W.8. Price 15s.
- ESSENTIALS OF HEAT, by O. M. White, *Head of Physics Department, College of Technology, Belfast*. Cloth 1961 208 pages. Cleaver-Hume Press, Ltd., 31 Wright's Lane, Kensington, London, W.8. Price 15s.
- TEACHING HIGH SCHOOL SCIENCE: A SOURCEBOOK FOR THE PHYSICAL SCIENCES by Alexander Joseph, *Professor of Physics, Head, Department of Mathematics and Physics, Bronx Community College, City University of New York*, Paul F. Brandwein, *Director, Division of Education, Conservation Foundation*, Evelyn Morholt, *Chairman, Department of Biology and General Science, Fort Hamilton High School, Brooklyn*, Harvey Pollack, *Teacher of Physics, Forest Hills High School*, Joseph F. Castka, *Chairman, Science Department, Martin Van Buren High School, Queens, N. Y.* Cloth. 1961. 674 pages. Harcourt, Brace & World, Inc., Burlingame, N. Y. $22\frac{1}{2} \times 16$ cm.
- PICKETT SLIDE RULES, SCIENTIFIC & EDUCATIONAL EQUIPMENT, Catalog. 1961. Paper. 23 pages. Pickett & Eckel, Inc., 1109 S. Fremont Ave., Alhambra, California. $28 \times 21\frac{1}{2}$ cm.
- ACTIVITIES IN EARTH SCIENCE, Laboratory Manual, by Namowitz. Paper. $27 \times 19\frac{1}{2}$ cm. 1961. 180 pp. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. Price \$2.20.
- CONCEPTS IN ELECTRICITY AND MAGNETISM, by Reuben Benumof, *State University of New York, Staten Island Community College*. Cloth. $23\frac{1}{2} \times 15$ cm. 1961. 374 pages. Holt, Rinehart & Winston, Inc., 383 Madison Avenue, New York 17, N. Y. Price. \$5.75
- SCIENCE TEACHING IN THE SECONDARY SCHOOL, by Nathan S. Watson, *Queens College*. Cloth. 13×19 cm. Pages xviii+328. 1961. Harper & Brothers Publishers, 49 East 33D Street, New York 16, N. Y. Price \$5.00.
- HISTORY OF THE EARTH, by Bernhard Kummel, *Harvard University*. Cloth. 17×24 cm. Pages xii+610. 1961. W. H. Freeman and Company, 660 Market St. San Francisco 4, Calif. Price \$8.10.

HISTORY OF SCIENCE CASES FOR HIGH SCHOOL SERIES, prepared by Leo E. Klopfer. All paper. All 20.5×26 cm. 1961. Graduate School of Education, Harvard University, Cambridge 38, Massachusetts.

- Case 1 THE SEXUALITY OF PLANTS. 24 pages.
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SUCCESSFUL SCIENCE TEACHING, by Milton S. Lesser, *Chairman, Science Department, Thomas Jefferson High School, Brooklyn, New York, Lecturer in Biology, City College of New York*. Paper. 14×19 cm. 64 pages. 1961. Teachers Practical Press, Inc., 47 Frank Street, Valley Stream, Long Island, New York. Price \$1.75.

A GUIDE TO EARTH HISTORY, by Richard Carrington. Paper. 10×16 cm. 284 pages. 1961. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. Price \$.75.

GREAT AMERICAN SCIENTISTS, by the editors of *Fortune*. Paper. 13×19 cm. Pages xii+144. 1961. Prentice-Hall, Inc. Englewood Cliffs, N. J. Price \$1.95.

WATER THE MIRROR OF SCIENCE, by Kenneth S. Davis and John Arthur Day. Paper. 9×18 cm. 195 pages. 1961. Doubleday & Company, Inc., 575 Madison Ave., New York 22, N. Y. Price \$.95.

THE NATURE OF VIOLENT STORMS, by Louis J. Battan. Paper. 9×18 cm. 158 pages. 1961. Doubleday & Company, Inc., 575 Madison Ave., New York 22, N. Y. Price \$.95.

ATOMS TO GALAXIES, by James Stokley, *Michigan State University*. Cloth. 14.5×22.5 cm. 361 pages. 1961. The Ronald Press Company, 15 East 26th St., New York 10, N. Y. Price \$6.00.

MISCELLANEOUS

STATISTICS OF STATE SCHOOL SYSTEMS 1957-58, by Samuel Schloss, *Head, State School Systems Statistics Unit*, and Carol J. Hobson, *Education Research and Program Specialist, under general direction of Emery M. Foster, Chief, Research Studies and Surveys Section*. Paper. 26×20 cm. 100 pages. 1961. United States Government Printing Office, Washington, D. C. Price \$.70.

GAMES OF STRATEGY: THEORY AND APPLICATIONS, by Melvin Dresher, *Research Mathematician, The RAND Corp.* Cloth. 23×15 cm. 186 pages. 1961. Prentice-Hall, Inc., Englewood Cliffs, N. J. Price \$6.75.

TECHNICAL WRITING AS A CAREER, by Allan Lytel, *Editor, STWP Review and Manager of Divisional Publications, AVCO Corp., Cincinnati, Ohio*. Paper. 23×15 cm. 1961. Bellman Publishing Co., Cambridge 38, Massachusetts, Box 172. Price \$1.00.

UNITED STATES GOVERNMENT GRANTS UNDER THE FULBRIGHT AND SMITH-MUNDT ACTS-LATIN AMERICA. Paper. 21½×14 cm. 17 pages. 1961. Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

COOPERATIVE-RESEARCH, by James C. Coleman *with the assistance of Kurt Jonassohn & John W. C. Johnstone*. Paper. 23×14½ cm. 75 pages. 1961. United States Government Printing Office, Washington 25, D. C. Price \$.30.

BARRON'S HOW TO PREPARE FOR HIGH SCHOOL ENTRANCE EXAMINATIONS, by Max Peters, *Chairman, Mathematics Department George W. Wingate High School, N. Y.*, Jerome Coleman, *English Department, Sheepshead Bay High School, N. Y.*, Jerome Shostak, *College Adviser, Lafayette High School, N.Y.* Daniel Gunsher, *Chairman, English Department, John Jay High School, N. Y.* Paper. 28×20 cm. 502 pages. 1961. Barron's Educational Series, Inc., Great Neck, N. Y.

UNITED STATES GOVERNMENT GRANTS FOR UNIVERSITY LECTURING AND ADVANCED RESEARCH ABROAD. Paper. 23×10 cm. 1961. 28 pages. Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

QUEST FOR QUALITY, by Samuel Baskin. Paper. 23×14½ cm. 18 pages. 1961. United States Printing Office, Washington, D. C. Price \$.15.

RESEARCH PROBLEMS IN MATHEMATICS EDUCATION. Paper. 23×14½ cm. 130 pages. 1961. United States Printing Office, Washington 25, D. C. Price \$.55.

SCIENCE AS A WAY OF LIFE, by Ellsworth S. Obourn, *Specialist for Science.* Paper. 1961. 27 pages. 21×9½ cm. United States Government Printing Office, Washington 25, D. C. Price \$.15.

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CAREERS IN SCIENCE MATHEMATICS AND ENGINEERING, by A. Neal Shedd, *Specialist for Science Youth Activities, Office of Education*, Anita K. Scott and James M. McCullough, *Wakefield High School, Arlington, Va.* Paper. 23×14½ cm. 39 pages. 1961. United States Government Printing Office, Washington 25, D. C. Price \$.25.

U. S. GOVERNMENT AWARDS 1962-63. Paper. 21½×13½ cm. 1961. Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

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OFFERINGS AND ENROLLMENTS IN SCIENCE AND MATHEMATICS IN PUBLIC HIGH SCHOOLS, by Kenneth E. Brown, *Specialist for Mathematics*, and Ellsworth S. Obourn, *Specialist for Science.* Paper. 23×14½ cm. 87 pages. 1961. United States Government Printing Office, Washington, D. C. Price \$.35.

ADVANCED STANDING, by Shirley A. Radcliffe, *Research Assistant Programs Branch, Division of Higher Education*, and Winslow R. Hatch, *Editor, Clearing-*

- house of Studies on Higher Education Division of Higher Education.* Paper. $23\frac{1}{2} \times 15$ cm. 24 pages. 1961. United States Government Printing Office, Washington 25, D. C. Price \$.15.
- RADIOACTIVE SUBSTANCES, by Marie Curie. Cloth. $18\frac{1}{2} \times 11$ cm. 94 pages. 1961. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price \$2.75.
- ENROLLMENT, TEACHERS, AND SCHOOLHOUSING, by Samuel Schloss, *Head, State School Systems Statistics Unit*, and Carol J. Hobson, *Education Research and Program Specialist.* Paper. 26×20 cm. 23 pages. 1961. United States Government Printing Office, Washington 25, D. C. Price \$.25.
- NATURE AND MAN'S FATE, by Garrett Hardin. Paper. 18×10 cm. 320 pages. 1961. New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. Price \$.75.
- ELEMENTARY SCHOOL LIBRARIES, by Jean E. Lowrie. Cloth $21\frac{1}{2} \times 13\frac{1}{2}$ cm. 235 pages. 1961. The Scarecrow Press, Inc. New York.
- PLANNING SCHOOLS FOR NEW MEDIA, by Amo De Bernardis, *Assistant Superintendent, Portland Public Schools, Portland, Oregon*, Victor W. Doherty, *Director of Research, Portland Public Schools, Portland, Oregon*, Errett Hummel, *Professor of Education, Portland State College, Portland, Oregon*, and Charles William Brubaker, *Partner, Perkins and Will, Architects-Engineers, Chicago, Illinois.* Paper. 29×23 cm. 72 pages. 1961. Division of Education, Portland State College, Portland, Oregon. Price \$1.00.

Book Reviews

- WONDER-WORKERS OF THE INSECT WORLD, by Hiram J. Herbert. cloth. 14×21 cm. 160 pages. 1960. E. P. Dutton and Co., Inc. New York City, New York, Price \$3.00.

This book relates the very interesting life stories of a dozen and more different kinds of insects including wasps, ant-lions, bees, beetles, butterflies, moths, preying mantises, mosquitoes, etc. Although the title of the book would lead one to believe that only insects are included in it, there are also interesting life stories of members of the arachnid group—garden spider, black spider, and others. The author does point out in the text that spiders are not classified as insects.

The text is lucid and written with a story-like but not a particularly scientific approach. The reader gets a feeling of almost human qualities ascribed to the members of the insect world. The following paragraph is typical. "But the ant's instinctive curiosity proves her undoing, and the evening roll call at the formicary (ant nest) reveals 'one missing.' Meanwhile, the ant lion has had its meal and watches the brink of the pit for another unsuspecting explorer. Invariably his waiting is rewarded." This particular text leaves the reader with the feeling that many activities of the insect and arachnid world are purposeful and carefully thought out.

There are more than a dozen black and white drawings which illustrate very well the doings of the insects as described in the text. The drawings add considerably to the meaningfulness of the book.

Children, ages 9-13, will probably find the book readable and meaningful. Compactness of print and the lack of colored illustrations may deter some children, while others may be drawn to it through the extensive index reference.

The last chapter points up the contributions of the insects of the world to the achievements of man. It points up also the success of insects as a group and the vast amount of information about them which is yet unknown.

ILLA PODENDORF
University of Chicago

THE STORY OF YOUR BLOOD, by Edith Lucid Weart, cloth. 21×21 cm. 64 pages. 1960. Coward McCann Inc. 210 Madison Ave. New York City. Price \$3.00

"Have you ever pricked your finger with a pin? And watched a red drop form?" These are two sentences with which the text begins. They represent the questions which are very real to children and the kind of questions which the author attempts to answer throughout the book. The text is very readable, not sharply organized but does follow a pattern of thought. The book is designed for children ages 9-13 years.

There is a considerable amount of art work. It is clear, in black and white and is designed to accompany the text. On some pages there are legends with the pictures which add to the understanding for the reader. Other pictures are without legends.

There are not many books upon such subjects as blood which are written for the young readers. Such books are welcome additions to libraries.

ILLA PODENDORF

CHEMISTRY FOR THE SPACE AGE, by Dan Q. Posin, Professor, Physical Sciences Course, DePaul University. Cloth. 22.5 by 17 cm. XIII+580 pages. 1961. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Illinois.

This new text by Professor Posin is a well-written textbook which is organized most effectively around ten units as listed below:

- Unit One: Matter, Energy and Their Changes
- Unit Two: The Nature of the Elements
- Unit Three: The Structure of Matter
- Unit Four: Atoms in Action
- Unit Five: Water, Solutions and Near-Solutions
- Unit Six: Acids, Bases and Salts
- Unit Seven: Families of Elements
- Unit Eight: The Realm of Metals
- Unit Nine: The Realm of Carbon
- Unit Ten: Chemistry and the Age of Space

The Text is well illustrated by pictures, diagrams, and doodling designs, or cartoons. The author should be commended for the problems and thought questions that are found in each chapter. Also, at the end of each chapter under "Highlights" appears a good summary of the important principles found in the chapter. The "Highlights" are followed by a thought provoking test over the chapter. This reviewer was pleased to observe an up-to-date bibliography at the end of each unit and to further observe that the references selected were of a type suitable for high school juniors and seniors.

One criticism that some teachers would make is the fact that acids and bases are defined only in terms of the Arrhenius Theory and no reference was made to either the J. N. Brönsted or the G. N. Lewis concepts of an acid and of a base.

Finally, one should say that the approach from the historical background is good. Pictures of famous chemists of the past are included. Also, pictures of more recent chemists, such as Enrico Fermi are included along with brief descriptions of their contributions to chemistry.

The approach is also psychologically sound in that the story of chemistry is told in an interest arousing and fascinating manner. Many copies of this textbook will probably be sold.

GERALD OSBORN
Western Michigan University

LIVING INSECTS FOUND ON ANTARCTIC PLATEAU

A few dozen hardy insects and mites have been found 6,000 feet above sea level in the Mt. Gran area at the head of Mackay Glacier about 90 miles from McMurdo Sound, Antarctica.

Keith A. J. Wise, a New Zealander working under a National Science Foundation grant for the Bernice P. Bishop Museum of Honolulu, came across the arthropods at what is believed to be the highest altitude at which insect life has been encountered on Antarctica.

While he was on a field trip, Mr. Wise found approximately two dozen collembola or springtails, a type of primitive wingless insects, under loose rocks on a surface of the plateau that was free of snow. In the same general location he also found about a dozen free-living nonparasitic mites.

Both insects and mites are arthropods, belonging to the phylum arthropoda. But mites are not insects, having four rather than three pairs of legs in the mature stage.

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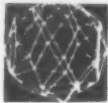
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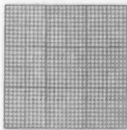
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